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ELECTRIC TRACTION.

THERE is little doubt that the time has now arrived when the construction of new lines adapted to be worked electrically, or the conversion of old lines to the electric method of traction, will be seriously proceeded with. In fact, as we remarked in a recent issue, the signs of the times portend a "boom in traction." Now a "boom," whatever its etymological significance, is of very considerable importance commercially. It sometimes happens that whilst a boom is a very satisfactory thing to look forward to, it is very unsatisfactory to look back upon. Such booms have not been unknown in electrical industries, but the prospects of electric traction are sounder than almost any other application of electricity. There will doubtless be some disappointments. The promotion of traction schemes has been suggested as a necessity for the maintenance of factories whose work in other directions has been either insufficient in quantity or undertaken at unremunerative prices. It has been suggested that "business" requires the creation of a new outlet for employment, and that "traction" will provide the much needed medium. Such considerations do not always result in the establishment of sound undertakings, or promote the general welfare of an industry.

It will be most gratifying if electric traction is the means of revivifying the condition of some of our manufacturing firms, but without desiring to minimise expectations, it is of vital importance that there should not be in tramway contracts a repetition of some of the methods that have been adopted in electric lighting work. There are manufacturers who can point to long lists of contracts which they have carried out for this and that municipality, but we doubt whether they are a penny the better for it. Others would have been wise if they had retired from business before they commenced. Next to losing a lighting contract, the worst that can happen is to obtain one. There is a danger that history may repeat itself in the application of electricity to tramways.

Before the busy period of electric lighting commenced, there were firms that existed on prospects; they simply hibernated in the hopes that when contracts were given out they might achieve some measure of success. The tide of contracts has flowed, and left some bad legacies behind, and a few manufacturers high and dry. We may be told that the public has benefited much, but if the public is to obtain benefit at the expense of electrical manufacturers, the sooner it gets its plant made at the co-operative stores the better. The greatest good of the greatest number may be all very well when applied generally, or not applied at all; but we refuse to admit its significance in relation to electrical work. It is true that low price contracts were the result of a policy deliberately adopted by some houses; as a policy it may have had some depth, but we fear life is too short to permit of its full fruition.

Electric traction will give great opportunities; our sincere wish is that they may not be spoilt. Electrical contractors will have probably fewer difficulties to contend with than in electric lighting. Much of the work will lie in the conversion of horse lines, and they will have the advantage of contracting for organised companies and corporations. It is only right to point out that at the outset English manufacturers will be subject to more competition from the outside than they have perhaps met before, and they will have to compete against excellent workmanship and wide experience. Having regard to the accumulated experience gained in America, it is natural to expect that the first roads in this country will be equipped entirely, or with some modifications, on American methods.

Electric traction work is as different as possible from all other electrical operations. Central station experience will not be of much use in equipping a tram line. The extraordinary conditions that are occasionally set up in a traction power house would send many a lighting engineer crazy. The output of many an American power house varies from a few to 2,000 horse-power in two or three seconds, and to adequately meet such astonishing variations, necessitates very different methods to those employed in lighting practice.

At the present moment there are probably 1,500 miles of tramways in Great Britain, representing an expenditure of nearly £14,000,000; when we say that the mileage of electric tramways does not exceed 40, there is a good deal to be done before electricity has much of a show. It would be sheer egotism to assume that those 1,500 miles are going to capitulate and adopt an electrical system off hand; indeed, there are many instances in which it would be most unwise to change present methods, apart from the question of increased capital expenditure. But we look to electricity to be used not only in the conversion of many old lines, but as a cheap means of working new ones; and we are convinced that the low working costs will have the result of suggesting many.

One of the strongest and most hopeful features of electrical traction is its municipal aspect. Tramway service is essentially a local one, and eminently suited to the control of a municipality. In the first place, the roads over which the tramways run are vested in the local authorities, and it is no easy matter to arrive at an agreement with a tramway company as to the use and repairs of such roads. It is unnecessary to say that there are some tramways worked by municipalities in this country which are not conspicuous for their success, and though this may be used as an argument against municipal ownership, we think it would not wholly apply to electrically worked tramcars. The difficulties in working a tramway system which municipalities have experienced will probably not be so great when electrically equipped. Electric lighting, when carried out by local authorities, has proved to be successful, and when there is a possibility of combining a lighting and tramway service there is much to be said in its favour.

Throughout this article we have assumed the trolley system of electric traction. So much has been said against it, and so much in favour of it, that to consider it now would involve useless repetition. Perhaps the argument advanced against it, which appeared to be the most serious, was that of interference with fire escapes. It should, however, not be forgotten that trolley lines in this country, to operate the high tramcars, will of necessity be considerably higher than most of the railway bridges. Those who will have it that our streets will be spoilt, will be best answered by the illustrations of the Bristol line given in another part of this paper. The opening of the Bristol line will sound the death knell to the prejudice against the trolley.

Power from Artesian Wells.

There is something unusual in the idea of obtaining power from a well, yet power to very considerable extent is obtained over a large area in South Dakota, and the current issue of *Cassier's Magazine* contains a description of several such wells, and illustrations of them as they appeared when spouting freely, similar to photographs we have recently received from Western Australia, where the water question on the goldfields appears to be in the way of solution by means of artesian wells. The Dakota wells are remarkable for their large output. One at Springfield, bored to a depth of 593 feet, and only 8 inches diameter, yields water at a pressure of 130 lbs. per square inch, and is driving a roller mill of 80 barrels daily capacity. The principal well is that at Woonsocket, pierced to 775 feet and 7 inches diameter, for it yields 5,000 gallons per minute with a pressure when closed of 165 lbs. per square inch, and drives a 3 feet Pelton wheel at a speed of 275 revolutions, saving £4 a day as compared with steam power. At Yankton is a well 500 feet deep and 8 inches diameter, with a pressure of 125 lbs., and stated to have cost £800. These high pressures are found in wells which exist in hundreds throughout an area of 400 miles by 150 miles, all east of the Missouri River, and the opinion is held that the sandstone into which they extend, and which yields such copious supplies, has its outcrop in the foot hills of the Rocky Mountains. The outcrop is clearly at considerable elevation above the site of the wells to account for the pressures. In this country we have nothing to seriously compare with these American wells. In Lincolnshire, 6-inch wells, pierced to the Lincolnshire limestone (oolite), will yield at the rate of 500 gallons per minute at 3 feet above the surface, and the water will rise to about 13½ feet above surface, more or less according to the surface elevation; and higher artesian levels are known, though in less marked supplies. Thus, on the moors above Accrington, we know of an artesian well flowing out by a syphon on the hill side somewhere about 1,000 feet above sea level, and, very near London, in and near the Wandle River, there is a considerable area embracing Tooting, Mitcham and Wimbledon, where there are numerous overflowing wells, some of which rise to nearly 20 feet above surface, and one, at the old Copper Works at Garrett Lane, has been flowing since the year 1834, the special date being fixed by the fact that when water was struck and suddenly spouted up and half drowned the men on the stage, they turned away their faces and saw the light of the conflagration of the Houses of Parliament. The late manager of the Copper Mills, Mr. Chambers, has a well within a couple of hundred yards of the old works, which has a level of 17 feet above surface, and flows at the surface at about 12,000 gallons per hour, being utilised by reason of its uniform temperature the year round of 51° F., and of its absolute purity, for the purposes of watercress growing. Over 20 years ago Mr. Chambers advised the proprietors of an adjoining works to make some use of their own spouting well by allowing it to flow upon an overshot wheel, and they put up a wheel for the purpose, and to this day the wheel is at work turning a colour grinding mill. It is the only example with which we are acquainted in this country of an Artesian well utilised for power purposes, the chief use for such wells, of which there are many within 30 miles of London, being for perennial watercress growth, their flow being constant where a few feet of margin is allowed for low seasons. The Chamberlain well in Dakota, which had so large a flow, is practically ruined from lack of sound work when put down, leakage taking place round the lining tube, and at one time threatening to destroy the mill. In this case the lining pipe parted, and with such great pressures great care is necessary in putting down bores, especially as some wells are apt to throw large amounts of mud, sand and stones. Only last winter a borehole, made on the hillside near a Sussex town, where the water was not expected to rise nearer than 50 or 70 feet below surface, began to spout liquid mud at an elevation sufficient to command the town 50 feet above the highest house therein, and it threw up large quantities of sand and clay, to the great inconvenience of the road drainage, the water, which was full of mud, being utterly useless as a town supply. But the largest of the overflows in England are comparatively small beside these Dakota outpourings, as well as equally diminutive in respect of their pressures.

ELECTRIC LIGHT AND POWER AT COPENHAGEN FREE PORT.

An object lesson in the practical application of electricity for all purposes in connection with dock work, is afforded by the electric light and power station erected and equipped for the Freihafen Aktiengesellschaft, at Copenhagen. The problem to be solved at this free port was to establish a station which would supply electrical energy for lighting and for all power purposes incidental to the discharging and loading of vessels, without the use of any other form of power as steam, gas, hydraulic, or compressed air; and at the same time to reduce to a minimum the employment of men as carriers, packers, &c.

The Copenhagen free port consists of four basins, protected by quay walls, extending some 3,800 metres in length, and by suitable moles. The depth of water ranges from 25 feet to 30 feet, so that vessels of deep draught can be readily accommodated.

The generating station contains three water-tube boilers constructed for a working pressure of 150 lbs.; four vertical compound condensing engines, each giving 100 H.P. at 210 revolutions; and five dynamos driven by belting. Three of the engines each actuate a six-pole generator giving 280 ampères at 240 volts at a speed of 490 revolutions; whilst the fourth operates two four-pole machines, yielding at 730 revolutions 135 ampères at 240 volts. There is also a battery, for the charging of which the voltage of any dynamo can be increased to 350 volts.

The distribution is effected by two networks of mains on the three-wire system. One at 240 volts is for power purposes, and the other at 110 volts is essentially for lighting, although small motors with, in some measure, a constant current consumption, are also connected to the latter system.

The halving of the 240 volt generator pressure is accomplished by means of the battery comprising 140 cells of 800 ampère hours capacity. The voltage is regulated by automatic double cell switches. In designing the station the object aimed at was to secure the highest possible economy, and at the same time to keep only one reserve machine for both power and lighting; as, on the one hand, reserve is provided by the battery, and, on the other, each dynamo can feed into both power and lighting circuits by means of the battery.

As the consumption of current for power purposes greatly exceeds that required for lighting, the two networks mentioned were adopted; there being installed motors to the extent of 460 H.P., and the lamps simultaneously, alight taking 110 H.P.

In the power network all the wires have the same cross-sectional area; in the lighting system the neutral is of about half the section of one of the outers. Altogether, some 35,000 metres of main conductors are employed, partly as underground cables, partly as bare conductors in conduits, and partly overhead wires on masts. The conductors to the quays in the eastern and western basins, branching to the warehouses, are arranged in conduits, 5 feet 8 inches deep, built in the quay walls. The power and light conductors to the north port are carried overhead. As the effect of sea-water was feared in the conduits, the bare conductors and iron brackets supporting them have been covered with marine lacquer, and those portions under sea level are provided with sumps from which any infiltrating water is removed by an electric pump.

Special interest is, however, centered in the utilisation of power in connection with the port plant. In the high "Silopackhaus" on the middle quay, a building of nine stories, are six bucket elevators operated by six electric motors each of 15 H.P. These motors and those used for other lifting purposes have been selected so that both by day and night service, with a full load, there is ample safety for overcoming exceptional resistances. Ordinarily these elevators raise corn from the cellars to the top stories. Two 12 H.P. motors are used to actuate windlasses, and two for driving travelling transport bands in the basement, and another for operating a corn cleaning machine in the second storey.

On the eastern side of the centre quay are two electrically driven cranes, running on rails along the quay, and by means of these, ships can be unloaded direct from the holds. Besides these, a variety of lifts and cranes are used in other parts of the free port.

The lighting network has connected to it 107 arc lamps of from 6, 10, and 15 ampères, and about 2,000 16-C.P. incandescent lamps. The arrangements are such that the arc lamps can be moved from place to place, as, for instance, on board the vessels when desired. The station, both as regards the variety of applications of power and of lighting, has been in successful operation for some months, the whole of the work having been carried out by the General Electricity Company of Berlin. A fuller description of the station occupying several pages, is given in the *Elektrotechnische Zeitschrift*, of September 5th, 1895.

ELECTRICITY IN GOLD DREDGING.*

By RALPH L. MONTAGU.

Before I go into the details of the electrical plant furnishing the subject of this article, a brief history and description of this old-time mining camp may not be without interest.

Grasshopper Gulch was discovered in 1862, and the reports of the fabulous richness of its bars brought hundreds of miners and their accompanying horde of followers to the spot. The town of Bannack grew up, became a place of 3,000 inhabitants in a short time, and finally arrived at the distinction of being the capital of the Territory of Montana.

The hillsides and river bars were all thoroughly mined for the precious yellow metal, and have yielded, in the aggregate, $20,000,000; owing, however, to the very slight fall in the river, the actual bed has never been extensively mined, work being confined to a few scattering spots where shafts were sunk to bed-rock, the dirt being hauled to the surface and then washed. This latter is the most expensive method of handling placer claims, but it has always been a paying investment to do so in this district, which of itself speaks for the richness of the ground.

After the first excitement had subsided and most of the travelling miners had moved to fresher fields, Bannack settled back into the town which we find to-day, with about 300 inhabitants, 25 miles from the nearest railway, and with the richest but most inaccessible placer claim in the State, lying in sight of and within easy stonethrow of the town.

It was left to eastern enterprise and capital to devise a method of reaching this gold that lies so near but yet so far from the eager hands of the never-tiring prospector. The Gold Dredging Company was formed in the fall of 1894 by Denver capitalists, and acquired the Bannack placer claim with its attendant water rights and other privileges. The method of handling the ground was then decided on, and has been followed throughout, with the exception of a few minor changes.

The first piece of work necessary was to dig a ditch large enough to carry the entire water of the Grasshopper Creek, then to build a dam that would give sufficient depth when the river was turned back into its original channel to float a dredge. A smaller ditch, which at that time reached a point two miles south of Bannack, and had been used for hydraulic purposes, was to be extended to a point directly opposite the town, the water from this ditch (300 miner's inches) to be used to give the necessary power to operate the dredge. The dredge was then to dig a pit some 300 feet by 500, the gravel removed to be elevated and washed in sluice boxes suspended by wire cables at the stern of the dredge, and the railings utilised to build other dams wherever they were needed. As soon as one pit is dug it will be pumped out by means of hydraulic ejectors and the bed-rock then cleaned up by hand, the dredge in the meantime digging another pit farther up stream.

Work was commenced in the spring of this year, and the dam was completed and the dredge launched on May 15th, and operations began June 14th.

The boat was built by Mr. H. K. McDonald, of Chicago, and the machinery supplied by the Bucyrus Steam Shovel and Dredge Company, of Milwaukee, Wis. The dredge is of

* New York *Electrical World*.

the elevator type, and delivers material into a sluice box at the stern of the boat, 25 feet above its water line.

It is arranged to excavate the material in front in order to make its own flotation, the cut being made wide enough to pass the boat through. A centrifugal pumping apparatus supplies water to the sluice boxes. The speed of the buckets is 20 per minute, and the discharging capacity is 220 cubic yards per hour. The bucket chain is composed of 26 links of 26-inch pitch, carrying 26 buckets of five cubic feet capacity each, and fitted with steel bottoms and protected joint connections of moulded rubber.

The material is first passed through a rotary grizzly having 5-inch openings, from which two iron chutes lead; one of these discharges the larger stone overboard, the other leads to the back elevator where the material which comes through the 5-inch springs of the grizzly is conveyed to the sluice box. The back elevator is similar in construction to the main chain of buckets, but lighter, since it has only to pick up the material delivered by the main chain.

Both chains of buckets and the rotary grizzly are driven by a motor of a capacity to develop 75 mechanical horse-power at the pulley. The type of motor chosen was the L. P. W. 20 railway motor of the General Electric Company. The switches, rheostat, circuit-breaker, and ampère-meter for this motor are located in the pilot-house.

A 15 horse-power motor is geared to two swinging drums, one on each side of the boat, for the purpose of holding the lines required to swing the dredge.

All switches belonging to this motor are also in the pilot-house. In order to hold the boat in position while working or moving ahead, two spuds, made of Oregon fir 18 inches by 18 inches by 40 feet long, and capped with iron points, are employed, being also operated by a 15 horse-power motor. The switches for this motor are placed on the main or machinery deck between the spuds, while on either side are necessary clutches to raise or let fall the spud that needs to be changed. The two 15 horse-power motors named are of the G. E.-800 type.

A 12-inch centrifugal pump capable of supplying 6 cubic feet per second into the sluice box, is operated by a motor developing 60 mechanical horse-power at the pulley. The necessary switches, &c., of this motor are placed in the pilot house.

The pilot house, from which the operator controls the entire machinery, deserves more than passing mention. The two mains enter from the stern and proceed directly to a main switch located directly in the centre and near the windows that look down at the main chain of buckets. This switch opens or closes the whole of the motor circuits, the lamp circuits being taken from the main wires before they reach this switch for obvious reasons. Directly to the right of the main switch is placed the bucket motor switch, and to the right of that a switch that opens or closes all the lamp circuits. To the left of the main switch is the swinging drum motor switch, and on the wall to the left is placed the pump motor switch and rheostat. The rheostat of the bucket-motor and reversing switch are placed in the centre of the pilot house, the former being boxed in and furnishing an extremely convenient table for any extra testing instruments that are occasionally used.

The wall on the right of the pilot house is occupied by a meter board. On it are placed four ammeters, one for each motor, and a voltmeter, all of the Weston type, round pattern; also, three circuit breakers for the bucket motor, pump motor, and swinging drum motor, respectively. The circuit-breaker and necessary switches for the spud hoist motor, are on the deck below, as before explained. The lamp circuit switches and fuse blocks are also placed on the meter board, all of the lamp sockets being of the moisture proof type.

A few readings from the different ammeters will be of interest. For instance, the pump motor throws six cubic feet of water per second, at 80 ampères. The G.E.-800 motors require from 15 to 20 ampères each to do their respective amounts of work. The bucket motor takes at times 200 ampères before it starts. The ammeter creeps up slowly as the resistance is cut out; whenever the digging is good, however, the meter reads only from 90 to 110 ampères.

The foundations of the machinery in the power-house are made of concrete, placed on a section of bed-rock that rose to a convenient elevation. The equipment consists of one Edison 500-volt 100-kw. generator, direct-connected by means of an insulating clutch to a 26-inch Pelton water wheel.

The pipe line is almost straight and but 760 feet long, in which a fall of no less than 330 feet is obtained. The material used was No. 14, No. 12, and No. 10 sheet steel, double riveted and with slip joints; the pipe is 18 inches in diameter and the running pressure 142 lbs. per square inch. Great care had to be exercised in anchoring the pipe line, owing to the enormous strains to which it is liable, due to the sudden variations of the load, as the governing is effected by means of a throttle valve.

A 2-inch pipe supplies water through an ½-inch nozzle to a Pelton water motor used to operate the differential governor. The governor consists of two pulleys running loose and in opposite directions on the same shaft. One pulley maintains a constant speed being belted to the water motor; the other pulley is belted to the shaft of the 26-inch water wheel, the speed of which varies according to that of the generator. A mitre gear is attached to each pulley, and these in turn engage two other mitre gears attached to a cross-head on the shaft. As long as both pulleys run at the same speed the shaft remains stationary, but when one pulley runs faster than the other the cross-head and shaft turn in the same direction as that of the faster pulley. This movement of the shaft is utilised by means of a suitable mechanism to open or close a throttle valve placed in proximity to the nozzle of the 26-inch water wheel. By this means the speed of the dynamo is kept practically constant.

The variation of load on the generator is, I venture to say, greater than that of any other plant in the United States. For instance, whenever the dredge gets into very hard digging and gets stuck fast, the pump motor is stopped and the buckets stopped and reversed until they are free once more. While this is taking place the load on the generator varies from zero to full load and back to zero, as often as 15 times in a minute.

Owing to the very slight fly-wheel effect the generator tends to lose its speed or race immediately the load is changed, but the differential governor checks these tendencies in a manner that speaks well for its efficiency.

It need hardly be added that the 100-k.w. generator which supplies the energy for two 20 H.P. motors, two 15 H.P. motors, 10 arc lamps and incidentally a few incandescent lamps, has all it can do to take care of its load.

From the switchboard two 16 by 10 cables, with weather-proof insulation, carry the current to the dredge. The problem of always keeping the dredge in electrical connection with the power house was solved by constructing a reel to take both cables. The inside ends of each conductor lead out through opposite sides of the reel, and are attached, by means of a set screw, to a flanged sleeve of machine steel, firmly fixed to and insulated from the reel. These sleeves revolve freely on two other sleeves that are attached in like manner to a stationary shaft. Each of these smaller sleeves has a collar turned on it to prevent end play, and also a set screw which holds the terminals of the solid conductors that go direct to the pilot house, from where, as before explained, the current is distributed to the different motors. Spoke handles are fitted to the periphery of the reel, and the cables can then be wound up or paid out without stopping the operation of the dredge for a moment.

The day the plant started, June 14th, a Montana shower was falling, or, as we call it in the East, a snowstorm was raging, but, although the reel is exposed to the weather at all times, there has never been the faintest ground or the slightest short-circuit perceptible in it. No doubt some will ask why the reel was not put lower down, or inside the covered portion of the boat. The answer is that by having the reel located as at present, between the spuds, it changes its position with reference to any given point on shore less than if placed at any other point on the boat, and, secondly, by having it located as high as possible it allows the boat to swing through its complete range without the cables having to be reeled.

Electrical Horology.—On the 16th inst. Mr. F. Hope Jones will read a paper, before the British Horological Institute, on "Electrical Horology."

DISTRIBUTION OF POWER IN COLLIERIES.*

By LLEWELYN B. ATKINSON, A.M.I.C.E.

The present position of the coal mining industry in the United Kingdom is one deserving of the most thoughtful consideration by all who are interested in the future commerce of the country, and the object of the present paper is to point out how some of the difficulties under which this industry at present labours may possibly be met. The difficulty to be contended with at present may be briefly stated. The possible output, indeed the output at which a reasonable profit can be earned, is greater than the demand at present prices; and even this demand is threatened by the decreasing price of foreign coal. From whatever point of view it is looked at, the question resolves itself into stimulating demand, and this can only be effectually done by lowering the selling price, which is impossible at present without extinguishing the profit.

To decrease the cost at the collieries, there are, broadly, three courses:—

1. To decrease the payment per ton to the mineral owner.
2. To decrease the wages cost per ton raised.
3. To decrease the fuel expenditure per ton raised.

The first of these is a matter outside the scope of this paper, the second will be briefly touched upon, and the third will be dealt with in some detail.

In the course of the last eight or nine years the author has been in close contact with mining operations in various parts of England and Wales, and the opinion has gradually been forced upon him that there is a very large margin of economy in wages and fuel to be effected. This arises from the fact that economies in labour and fuel which are studied and insisted on in engineering and manufacturing industries are hardly considered in coal mining, at all events in the majority of instances. This broad fact must appeal to every mind that, whereas in almost every manufacturing process or industrial operation the product per man has nearly doubled and the consumption of fuel been halved within the last 15 years, in coal mining the product per man has been practically stationary, and the cost of fuel per ton raised probably nearly so. This is frequently attributed to the stringency of mining legislation, but legislation has largely affected other industries also, and the result cannot be altogether attributed to this cause.

It would be a long task to enumerate the causes which, in the author's opinion, contribute to this result; but, broadly, it appears to him that what is required, is to do in mining what has been done in every other department of industry, *i.e.*, to lower the cost of wages and material per ton by increasing the product per man and per pound of fuel by the following means:—

1. Improved organisation, both in the working, and more especially in the original laying out of the scheme of working a colliery.
2. More superintendence and supervision underground by thoroughly well informed mining and mechanical engineers.
3. The greater use of mechanical power instead of human and horse labour, and a more economical production of that power.

In short, substitute brains and mechanical power for human labour.

It has been already stated that the immediate object of this paper is to deal with the question of the economical production of power; but a few remarks on the subject of mechanical power in collieries may be useful.

The getting of coal resolves itself into cutting and filling and hauling to the pit bottom.

In the great majority of collieries both cutting and filling are done without using any mechanical power whatever, and the progress made in introducing mechanical coal-cutters is slow, at all events in this country. A considerable experience, extending over some years with coal-cutting machines in various collieries and various parts of the country, justifies the author in saying that there are hardly any seams under 3 feet 6 inches in thickness that could not be more cheaply worked by mechanical coal-cutters than by hand labour, and with a better product of round coal; but that in probably not 5 per cent. of the collieries of the country is the existing organisation of the filling and haulage sufficiently good to enable machines to be worked with that regularity which will make them pay.

This is the secret of the otherwise unexplained fact that some few collieries have been and are worked by machinery with marked success, whilst the reverse holds good of the majority of cases in which it has been tried. Organisation and superintendence, those are the only secrets of success in cutting coal by machinery; till they are forthcoming, mechanical assistance in this direction must be postponed.

In thin seams much might no doubt be done to apply mechanical power to reduce labour and breakage in filling the coal, but the same remark applies as to coal cutting.

The use of machinery in the coal face would so much reduce the length of face under work for a given output, that the roads on to the face being less in total length, could, without increased cost, be kept in a condition enabling mechanical haulage to be used right up to the face, doing away with horses and ponies altogether. These are some of the directions in which mechanical power may be looked for to profitably enable the output per man to be increased. But before this can be done, much will have to be done to improve the general organisation both above and below ground. And this may well be commenced by the economical laying out and conduct of the arrangements for the generation of power above ground.

Consider the conditions under which this is at present carried out.

Generally speaking, when sinking operations are completed, a winding engine is put down. Subsequently, as the workings extend, haulage is considered, and some plant, either steam, compressed air, or electrical is provided for this. Later, perhaps pumping becomes necessary, and again a plant (perhaps on another system) is put in. There are various engines at the surface for the screening, repairing shop, and other purposes. All these are of uneconomical types; so there ensues, at every point, waste of heat, waste of steam, particularly when, as in some cases, separate boilers are put down for each plant. And the answer to any criticism generally takes the form: "Oh, fuel is so cheap at a colliery, that it does not matter." Why is the fuel so cheap, that is, of such low value? Because it is so small—smashed in hewing, smashed in filling, smashed on the screens, due to imperfect methods and appliances at every point. But, at any rate, it is worth at least 2s. 6d. per ton, and it is generally estimated that from 5 per cent. up to even 10 per cent. of the total output by weight of the collieries is consumed at the surface, and this means, even taking the lower figure, about 9½ million tons, worth about £1,190,000 per annum.

It has been stated by Mr. Foster Brown* that the probable consumption of coal in colliery engines, taking an average, would be not less than 6 lbs. per H.P. hour. Taking this to refer to indicated horse-power, it is possible to produce the same power with 1½ lb. of coal, or even less, hence it may be fairly said that there is a possible saving to be effected of 75 per cent., worth annually nearly £900,000. It would probably be well within the mark to say that the saving to be effected in labour of handling, and in the maintenance of boilers and appliances for consuming this, would be worth, in addition, say, 65 per cent. of the above sum, showing a possible economy of, say, 1½ millions sterling per annum, a sum equal to over 2 per cent. on the total value of the coal raised, or about 3¾ per cent. of the whole wages annually paid in the mining industries; and if the coal were raised unbroken, so that its value was equal to the average value of the coal sold, these figures would rise to 3 per cent. of the value of the total coal raised, or 6 per cent. of the wages paid.

It may be stated at once, that to realise these economies the power required must be produced by compound or triple expansion condensing engines, appliances almost unknown in colliery work, and to do this there is no doubt that the whole power required at the colliery must be produced in one, or at most, two engines, and distributed with as little loss as possible to the points where power is required. There are various methods of distributing power, but some of them are only applicable to particular cases, or in particular circum-

* Read before the South Wales Institute of Engineers, 1895.

* See address, British Association, Mechanical Science Section, 1891.

stances; the only two of general applicability are compressed air and electricity.

Of these, whilst under favourable circumstances, compressed air can be made to give a favourable efficiency, its application in mining is discounted by two important considerations of economy. To utilise compressed air with efficiency—(1) the pipes must be free from leakage, (2), the air must be heated before being used. These two conditions are practically unrealisable, and hence the efficiency of air transmission in collieries is and must necessarily be low. The cost of plant and extended air mains is also high.

The advantage, therefore, in point of view of first cost and efficiency as a means of distributing power rests with electricity; the economy of the cables compared with air mains, and the facility for extension and alterations to the position of the machinery, make electricity an ideal means of distributing power.

There is, however, a question to which I must refer, viz., that of safety. This question of safety is one which has from the first introduction of electricity in mining been prominently before engineers; though it may be noted that among those who have had practical experience of its use in mines the objection is rarely raised. In a paper read in 1891 before the Institution of Civil Engineers by the author, in conjunction with Mr. C. W. Atkinson, this question was somewhat fully dealt with, and certain conclusions were arrived at which time and experience have gone to confirm, but, as this question is to some minds still an open one, and as additional experience has added to the knowledge of the subject, it may be well to deal with it again at some length.

There are two distinct questions:—

1. The safety of an electric motor, which may spark at the commutator.

2. The safety of a system of cables, which may be ruptured whilst carrying an electric current.

Dealing with the first of these, it has been shown from theoretical considerations and by practical tests that the amount of sparking which exists with electric motors of good construction is unable to ignite firedamp, owing to the fact that the temperature is never sufficiently high, and it is only, therefore, in exceptionally abnormal circumstances, such as a brush falling out of its holder or becoming displaced absolutely on the commutator, that the inflammation of firedamp can be effected; and it has also been shown conclusively by experiment that there are in the market methods of enclosing either the whole machine or the armature and commutator,

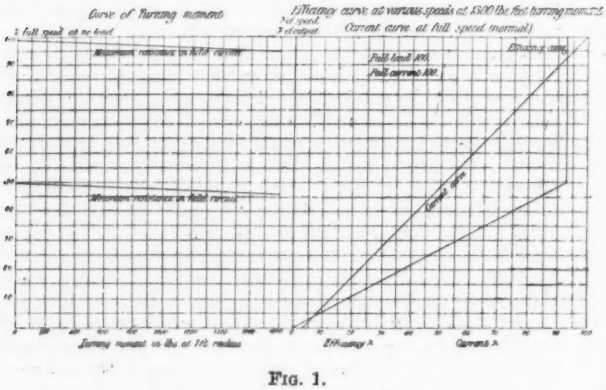

Curve of Turning moment
Efficiency curve at various speeds at 1500 lbs feet turning moment
Current curve at full speed normal)
Full load 100
Full current 100
Efficiency curve
Turning moment in lbs at 1/12 radius
Efficiency %
Current %

Fig. 1.

or the commutator alone, which, even under these abnormal circumstances, entirely prevent either the access of firedamp or the ignition of firedamp outside the machine.

Practical experience is in accord with experiment and with the principles named, and the author knows of no recorded instance where there has been an accident from the use of an electric motor in a coal mine. In connection with this, reference may be made to the question of "commutatorless" motors worked by multiphase alternate currents. As the principles on which these motors work are little understood, the author has appended to this paper some notes on the subject, but a few points are especially worthy of consideration. The first is that although such a motor may have no commutator, if it has to be regulated as to speed, or to start with the load on, it must have brushes and collecting rings, in which case the displacement of the brushes under abnormal circumstances may have in a modified proportion the same result as in an ordinary motor. Another circumstance in connection with such motors as at present constructed is that the maximum turning moment they will give has a limiting value, beyond which it decreases as the load increases, even although the current increases, and that at any other than the normal speed the efficiency rapidly falls. Curves are given (fig. 2) showing the maximum turning moments given at different speeds, and the efficiencies are shown. For

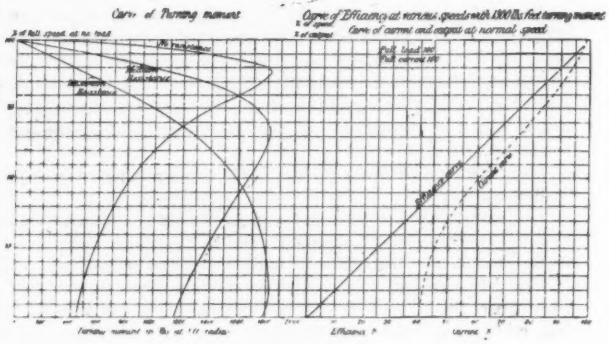

Curve of Turning moment
Curve of Efficiency at various speeds with 1500 lbs feet turning moment
Curve of current and output at normal speed
Full load 100
Full current 100
Efficiency %
Current %

Fig. 2.

comparison similar curves are given (fig. 1), for a motor in which the speed is controlled by varying the strength of the magnetic field, using continuous current. A further point is that with such motors the losses in the cables and the dynamos, which with continuous currents are proportional to the power transmitted, are not proportional in the case of alternate currents, whilst in addition, as 250 volts alternating will give the same "shock" as 500 volts continuous, which is generally treated as the maximum advisable in a colliery, the cables have to be of about twice the area of section for the same power; hence these various considerations contribute to this, that the advantage of such motors at full load and full speed are to be balanced against their disadvantages at less than full load and at other speeds, and in the particular case of colliery transmission these points are large factors.

Returning now to the second point in the question of safety, viz., the possible breakage of a cable. This may be at once overcome if the cables are buried below the surface, but as this method has the disadvantage of expense, and frequently of deterioration of the cable, we may consider the case of a cable hung from the walls or timbers.

In this case if the cable does break the ends are quickly parted, the spark may continue for the fraction of a second, but it has been shown by the experiments of Messrs. Wüllner and Lehmann at Aix-la-Chapelle, which experiments were accepted as conclusive by the Prussian Firedamp Commission, "that even violent sparks from rupture of the current, accompanied with the explosion of fragments of iron in a state of combustion, had no effect on the inflammation of firedamp."*

Considerable light has, in the author's opinion, been thrown on this question by the facts recently stated by Prof. Vivian B. Lewis. It appears that the ignition of firedamp arises in most cases, not from the raising of the temperature to the ignition point of firedamp, which is very high, but by the raising of it to the point of its decomposition with evolution of hydrogen, which, becoming ignited, eventually ignites the firedamp. This requires two things:—(1) Time (and Prof. V. Lewis states that 10 seconds is in some cases necessary); (2) the maintaining of a particular mass of gas in contact with the point where the heat is developed long enough to effect the operation quoted. Neither at the commutator of a motor, nor at the point of rupture of a cable are these conditions fulfilled. In the face of the facts and experiments and experience now at disposal, those who raise the objection to electricity in mining on the ground of safety ought, in the author's opinion, to bring some proofs of that danger if it is to receive consideration. Notwithstanding

* *Colliery Guardian*, February 20th, 1891.

the extended use of electricity, these causes of accidents do not occur, and, in the opinion of many well qualified to give it, the danger arising from electricity is less than that arising from safety lamps, and enormously less than that arising from almost any explosive agent now in daily use.

Having dealt with this question, it remains to be asked, is the present position of power distribution by electricity such that we may use it with confidence for the whole of the power required at a colliery? The author's answer to this is, yes. In support of this may be given the following facts:—

The largest engine at a colliery is the winding engine, and suppose this to require to be capable of developing power at full speed of 1,000 H.P., which is an outside figure, this could be well replaced by two motors of 500 H.P., one on each end of the shaft of the drum, without gearing. There are numerous cases of dynamos and motors of this power working with ease and satisfaction and giving no difficulty whatever, and operated by ordinary mechanics with no more trouble than an ordinary steam engine. Motors of smaller sizes are in use all over the world, with universal satisfaction as to ease of manipulation and low cost of maintenance.

Are the claims made for efficiency of electric distribution of power realised? On this point the author has examined carefully tests made by himself and by others on electric power plants, and has arrived at this conclusion—whilst the efficiency of distributing electric power and its utilisation in the motors does come up to that claimed, the efficiency of the production of electricity is not, as a rule, as high as is claimed, or as high as may be realised, and the reason is this: sufficient account is not taken of the fact that the average load is considerably less than the maximum requirement, and the curve given (fig. 3), which is taken from an actual test of a direct coupled engine and dynamo, will

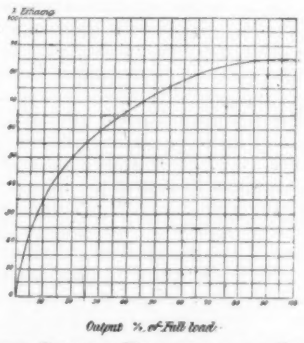


Fig. 3.—Curve Showing Efficiency of a Steam Dynamo (Willans engine direct-coupled).

show how this operates. Whilst the efficiency of electric generation, that is, the proportion between the electric power delivered to the cables and the indicated horse-power of the engine, is as high as 86 per cent. at full load, it falls to 74 per cent. at half-load, and to about 58 per cent. at one-quarter load. The reason for this is to be found in the power the engine takes to drive itself. The engine is generally arranged to work with an economical cut-off at the full load or maximum power, and consequently is larger than necessary for all smaller loads. It should be arranged to work with an economical cut-off at the average power, then at a larger power; although the consumption of steam per I.H.P. would be somewhat greater, the mechanical efficiency would be so much better at the average load that considerable economy and, indeed, the best possible result would be obtained. The moral is to use engines with automatic expansion valves, permitting the engine to work with a cut-off as late as half or five-eighths of the total cylinder volume when developing the maximum power, and working with a more economical grade of expansion at the average load.

To apply the principles advocated in this paper, the method to be adopted should be as follows:—When a colliery is opened an estimate must be made of the power which will ultimately be required for the whole colliery. It need not be all provided for at once, but the arrangements must be such that what is provided will be worked at an economical load, and that by simple duplication it may be increased.

An example is given below which may be considered to represent an average case, where there is no very heavy pumping.

Table of Power required at a Colliery.

	Maximum Power H.P.	Average Power H.P.	Minimum Power H.P.
Winding	700	225	0
Fan engine	60	60	60
Pumps	50	50	50
Haulage	200	100	0
Lighting	20	10	10
Screens	20	20	20
Shops at surface	20	5	5
Capstans for waggon handling ...	20	10	10
Total	1,090	480	155

The power required by the winding and haulage engines are what would probably be required in a colliery drawing about 1,500 tons per day, and the maximum power required by the winding engine is reckoned on the assumption that the weight of the ropes is unbalanced, and the average on the assumption that the winding takes 40 seconds and the unloading and loading 25 seconds. Variations will correspondingly affect these points, and must be made to suit each case.

These powers set down are those required at the separate machines, and if we take it that the loss in the cables at full load is 5 per cent., which will be ample, as the bulk of the power is not far from the source, and that at the average load and upwards the indicated power is as shown on the curve (steam dynamo efficiency, fig. 3), that is, $\frac{100}{86}$ of the power delivered to the cables, we get the following as the indicated power required at each load, which, assuming that the electric motor will transform only as much electric power into mechanical power as a steam engine would convert of indicated power into mechanical power, gives a direct comparison between the actual indicated power required if all the engines were worked direct from the boiler, or by the distribution thus to be effected.

Indicated H.P. of Generating Engines.

Maximum	Average	Minimum
$\frac{100}{8} \times \frac{100}{95} \times 1{,}090$	$\frac{100}{8} \times \frac{100}{97{\cdot}5} \times 480$	$\frac{100}{64} \times \frac{100}{95} \times 155$
1,330	572	265

Now, it will be observed that the average power is 572 I.H.P. as compared with 480 I.H.P. actually required at the engines. But taking for the former Mr. Foster Brown's figure of 6 lbs., and for the latter 1½ lbs., the economy resulting is found from the fraction—

$$\frac{6}{1{\cdot}5 \times \frac{572}{480}} \text{ or } \frac{6}{1{\cdot}78} \text{ or } \frac{100}{29{\cdot}6}.$$

Not far differing from the possible economy spoken of early in the paper.

That such figures are realisable in practice is shown by the figures given in a paper read before the North of England Institute of Mining Engineers by Mr. Alexander Siemens, and published in Vol. viii., Part 2, of the *Transactions* of the Federated Institution of Mining Engineers.

Tests are there recorded where, with a plant considerably smaller than that here considered, a consumption of 2·62 lbs. per E.H.P. hour, equivalent to 2·25 lbs. per I.H.P. hour, were obtained; and in the discussion on the same paper reference was made by Mr. D. B. Morison to a plant using 2 lbs. coal per E.H.P. hour, equivalent to 1·72 per I.H.P.

The writer is aware that in thus advocating the generation of the whole of the power in one engine, or pair of engines, he is advising a very radical departure from existing and well tried methods; but the advantage in economy is so great that in his view, a revision of method must take place, and in any case the subject is well worthy of consideration and discussion.

Notes on the Fundamental Principles of Multiphase Electric Motors.

The principles on which the action of these motors depend may be explained in general terms as follows: the explanation referring in particular to a three-phase system.

Suppose in figures 4, 5 and 6, there are three electro-magnets radially fixed in positions O A, O B, O C.

Suppose, by means which need not be gone into, they are magnetised in rotation, that is, first, as in fig. 1, O A.

There will then be a magnetic axis, O A.

As O A is demagnetised, let O B be magnetised, the magnetic axis has reached O B.

Repeat this with O C, and finally again with O A.

The magnetic axis has been in each of the positions, O A, O B, O C, and now is at O A. This result is the same as if O A only existed, and had been mechanically rotated round the point, O, one revolution.

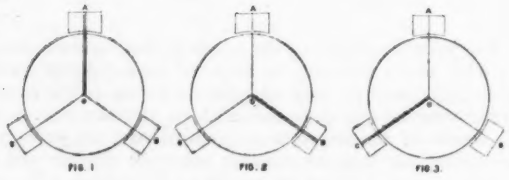


FIG. 1 FIG. 2 FIG 3.

FIGS. 4, 5 AND 6.

It was shown by Arago, as long ago as 1826, that, if a magnet is rotated round a conducting body such as a copper plate or cylinder, electric currents are produced in the conducting body, which currents attract the rotating magnet, and thus the conducting body is dragged round by the rotating magnet.

If, therefore, there is a cylinder of copper or of iron covered with copper conductors surrounded by such magnets, through which the current is in turn passed, producing a rotating magnetic axis, the cylinder will rotate. In practical working the currents are made to rise and fall in each magnet by using alternate currents, that is, currents rising and falling in the circuit, and arranging them so that the maxima in each of the circuits follow one another in the order described, and hence the name *multiphase* for the phase of the current in each circuit differs.

Curves showing the turning moment (*torque*) exerted by a three-phase motor, copied from an article on "Electric Traction," by Philip Dawson, in *Engineering* of May 24th, 1895, are given in fig. 3.

The ordinates show the speed of the motor expressed as percentages of the full speed taken as 100.

The abscissæ show the turning moment in pounds at one foot radius.

The three curves show the effect of adding resistance to the circuits of the conductors on the rotating cylinder. For instance, a turning moment of 1,820 lb. feet is given at about 88 per cent. of the full speed with no resistance in circuit. The same turning moment is given at 68 per cent., with some resistance added, and at 10—15 per cent. with a maximum of resistance. Taking the working load of this motor to correspond to 1,300 lb. feet turning moment, the efficiency curve of such a motor is shown at the right hand side of the same plate. This curve is only an approximation, but will not differ much from the actual curve. The curve of current used is taken from tests of a three-phase motor made by the Allgemeine Elektricitäts Gesellschaft (Berlin), and shows that when the power falls from 100 to 0, the current falls from 100 to 40, the speed being the normal speed of the motor.

Fig. 1 shows comparative curves for a continuous current motor, with field magnet regulation, the supply being at constant pressure. It is assumed that the magnet strength may be doubled, taking that required to give the full output of the armature at normal speed as unity.

The curve of turning moment of such a motor (fig. 1) may be made a straight line at any speed between 100 per cent. and 50 per cent. of the normal speed, and by inserting resistance in the armature circuit at any speed below this, it may be regulated to have any value at any speed, only defined by the ultimate current the armature will carry without burning up or mechanical breakdown.

The efficiency at full turning moment by regulating the field will remain about 92 per cent. at all speeds down to 50 per cent. of the normal speed, after which it will fall with the speed.

The current will at full speed be proportional almost exactly to the work done.

The curves given are typical, to allow of comparison with the three-phase motor, and do not refer to a particular motor.

A curve showing the efficiency of a steam dynamo (Willans engine), direct coupled at different loads, is given in fig. 3.

The ordinates show the efficiency percentage, the abscissæ, the percentage of the full load output, the economical load for the engine being when fully loaded.

OBITUARY.

SIGISMUND SCHUCKERT.

ON September 16th death put an end to the long and severe sufferings of Sigismund Schuckert, the founder of the Schuckert establishments.

That the important part which he took in the development of electrotechnics was rarely recognised to its full extent was probably due to his extreme modesty. He has not only been the creator of one of the largest electrical establishments in the world, but the extensive use of continuous current arc lamps is especially due to him.

Sigismund was descended from a family which had long been established at Nürnberg, and was born there on October 18th, 1846. He obtained his training in practical mechanics at Holler's mechanical works. After completing his apprenticeship his wanderings began, and he worked for 5 years at Stuttgart, Hanover, Berlin and Hamburg. Here a longing for foreign lands may have been excited in him by the business of the seaport and the social life of the free Hanse town. In May, 1869, this wish was gratified by a journey to America, where it was not difficult for the active and clever mechanician to find a livelihood. Here he became acquainted with Thomas Alva Edison. He was active for 4 years at New York, Baltimore, and Philadelphia. In 1873 he returned to Europe, not with the intention of remaining here but of returning to America. Fate determined otherwise. His native city, Nürnberg, retained him, and he was prevailed upon to establish a workshop in his parents' house in the Johannis Street. He soon transferred it to the Schwaben Mühle, one of those old industrial establishments driven by water power. Here he worked for a time with a single assistant. At first he produced instruments of precision, and a pedometer of a novel construction was brought out at this time. He did not neglect his theoretical culture, however, and many marginal notes in the volumes of the Schuckert library give evidence of his industry. About this time he constructed his first dynamo. He relates how a friendly physicist wished to demonstrate that the machine which he was about to build could not act. The machine, however, acted so well that after being in use for 20 years it was bought back, still in serviceable condition, in memory of the past days. This machine, and those which followed it, were intended for use in galvanoplastics for silvering, nickeling, &c. For a long time he was engaged with the idea of producing an electric light which at that time was scarcely known by name, and in 1875 he had the pleasure of setting the first electric illumination in action. It was at the Sedan commemoration 20 years ago when the first arc lamps were used at Nürnberg. The correct insight with which he then determined his machine was to be, for him, of importance. The model which was subsequently carried out as Schuckert's "flat ring machine" marked for many years the summit of electrical achievement. It was not known then how to avoid the heating in the armature by sub-dividing the iron in thin plates and by powerful field-magnets, but among the machines of that time which had more copper on the armature than in the field-magnets, Schuckert's construction, easily ventilated and taken in pieces, was of the highest importance.

But the extended use of the continuous current arc lamp was destined to give the greatest impulse to Schuckert's work. Here Schuckert evinced the fullest command of the position. Then, when the alternating current lamps of

Jablochkoff and Siemens were most prominent he strove after the production of an effective continuous current lamp, and acquired the patents of Krizik. Under the name of the "Pilsen lamp" it penetrated into England, and from this lamp we must date the divided continuous current arc light.

The consequences of the introduction of the arc lamp were manifested in the development of Schuckert's works. The space in the Schwaben Mühle had long been found insufficient, and the works extended into the Schlossäcker Street. In 1883, 100 workmen were employed, and in 1886, 200. With equal success Schuckert took in hand the parallel system of glow and arc lamps, especially the arrangement of arc lamps in pairs and of glow lamps at 100 volts. However ordinary and simple these things appear to us now they experienced at first violent opposition. His representative at that time, Alexander Wacker, at present the General Director of the Schuckert works, fought diligently in the technical journals for the new invention. Schuckert himself in a polemical essay, wrote, that time would prove the accuracy of his views. That he was right is proved by the constantly increasing development of his works.

In 1890 a thousand workmen were employed. He showed equal tact in the selection of his coadjutors. Among them are the well-known electricians, Uppenborn and Hummel. The management of the business was assigned to A. Wacker. By their joint activity a new field of enterprise was secured, the erection of central electric stations for illuminating entire cities. The results are too well known to be insisted on further. For the manufacture of dynamos, arc lamps and measuring instruments, as well as the accessory apparatus, more than 2,000 workmen are employed in the new works in the Landgraben Street.

How fully Schuckert was able to estimate the scope of new inventions appears not less from the introduction of the reflector. When Prof. Munker suggested to him to produce concave mirrors of glass by a parabolic motion of the polishing tool he took up the idea with zeal. At this task he worked untiringly till success crowned his labours. Many a reflector was broken before the first useful specimen appeared. When on submitting them to the military authorities the superiority of the parabolic reflectors was brilliantly demonstrated, he felt no little pride when Werner von Siemens, who was always ready to recognise the merit of others, went up to him, took his hand and said "Siemens bows down to Schuckert." He eagerly awaited the moment when the largest reflector in the world should send out its mighty rays at the Chicago exhibition.

Amidst all these successes, Sigismund preserved a modesty which was almost proverbial. Many a visitor at the Frankfurt Exhibition passed regardlessly by the eminent man who never obtruded himself, but preferred to be lost in the crowd.

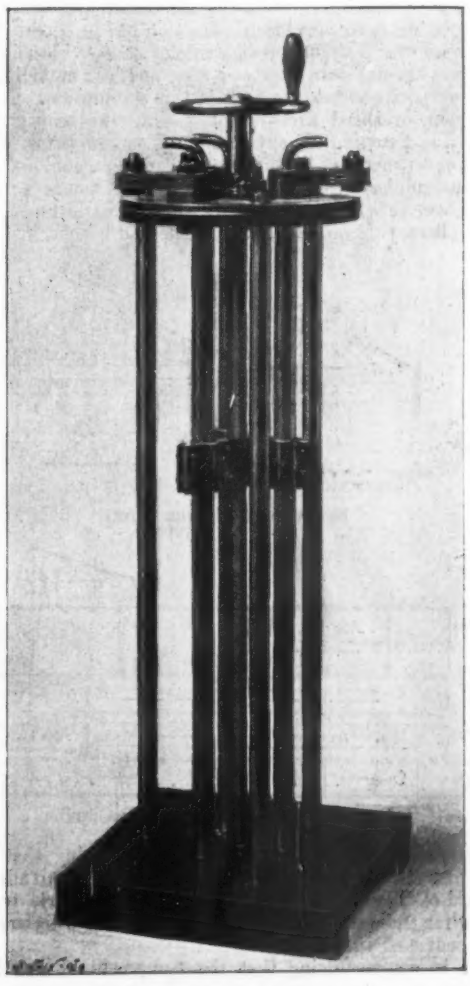
To his workmen and staff he was always a kindly father—indeed, he was simply spoken of in his works as "the father." Even during his last illness he was engaged with devices for the benefit of his workmen and officials.

He was not destined to see the last triumphs of his work. A nervous affection put an end to the activity of the energetic man, who, even during his disease, would allow himself no repose.

Whoever knew him, his untiring industry, his open and unassuming character, and his constant regard for others, can never forget his personality.

REGULATING RESISTANCE.

THE illustration shows a regulating resistance which has been made by Messrs. Crompton & Co., Limited, for Major Cardew of the Board of Trade, for the use of the Board of



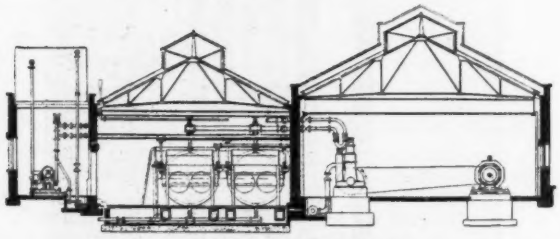
Trade Standardising Laboratory, for regulating currents used in the Kelvin balances, more particularly the 2,500-ampère instrument. The overall dimensions of the apparatus are 3 feet 6 inches by 15 inches by 15 inches approximately, which, taking into account its range of 60 to 5,000 ampères is one of the smallest resistances ever made. Briefly described it consists of three tubes through which water is

passed, carrying away the heat produced by a current density of something like 30,000 ampères per square inch. These tubes are arranged triangularly in the centre of the base, the three outer tubes being supports for the top and do not carry current. The three inner tubes, seen in line, are of manganin, and will be ordinarily used for currents up to 1,500 ampères or more, having terminals at one end. They are connected up by means of a travelling brush connection which is adjustable by means of a screw and wheel handle. The third tube, the one on the right-hand side, is of copper and of larger special area than the manganin tubes. This is used as a common return for the manganin tubes running parallel for currents over 1,500 ampères. The connections are heavily made and of copper of the sandwich form, water being admitted by means of the tubes shown, similar tubes being suitably connected together, being placed in the base.

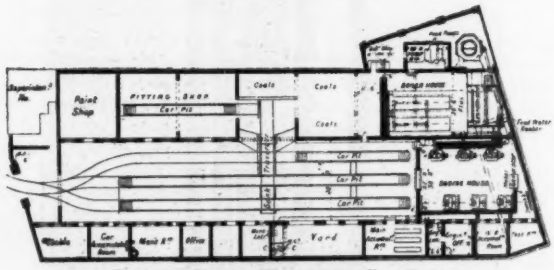
THE BRISTOL ELECTRIC TRAMWAY.

In all human probability the Bristol Electric Tramway will be opened on Monday next. It is not the first to be opened in this country by three or four, but it will have so important a bearing on the question of electric traction in Great Britain that we shall have to date our history in traction from its inauguration. The event is so significant that we are inclined to indulge in a laudatory song or a Latin phrase were it not that our dignity might suffer some abatement.

We are not going to make this the occasion of considering the question as to why electric traction has been retarded in this country. The reasonable employment of electricity on tramways assumed an overhead wire, and our municipal and local authorities made the most of this assumption. In their judgment overhead wires meant spoiling the beauty of our streets, and cutting the sky into long narrow strips. There is, however, nothing like an ocular demonstration, and if the various municipalities will indulge their proneness to travel, we believe the Bristol Tramway will be an instance where their journeying might result in some real benefit.



Elevation of Power House.

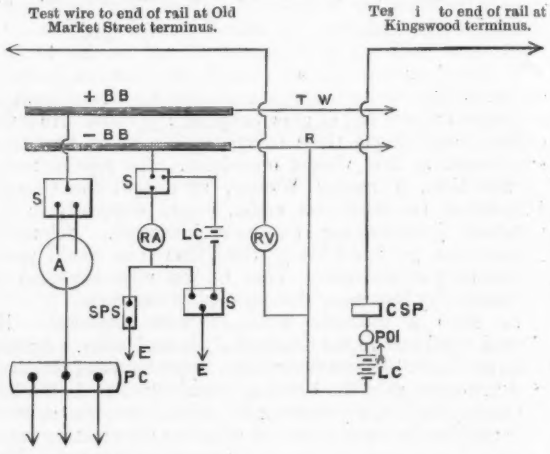


Plan of Power House and Car Shed.

Technical men will be interested in knowing that this is the first electric line which has been compelled to adopt the Board of Trade rules for the regulation of electric traction. How far these rules have been complied with will be seen in the course of this article.

It is not surprising that the equipment of the Bristol Tramway has been carried out on distinctly American lines. Indeed, the Bristol Tramway Company were wise in entrusting the work to contractors whose experience had been gained mainly on American tramway work. The most important feature of the system, however, is one that is English in its origin; we refer to the trolley which is evolved from the principle suggested by Mr. Dickinson, and employed by him on the South Staffordshire tramways.

That part of the Bristol Tramway Company's line which is now equipped with electricity commences near the centre of the town, and extends to Kingswood, a distance of about four miles. Formerly the line as far as the Power House was worked by horses, but they were found to be utterly unsuited for the difficult road. The rest of the line is entirely new. Throughout the entire length of the line ordinary vehicular traffic is considerable, and becomes very crowded near the

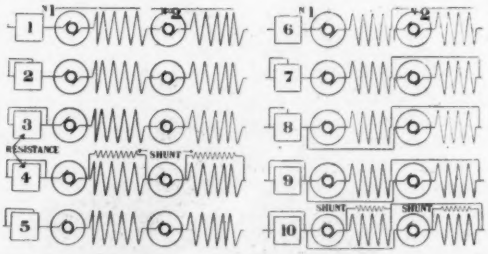


To generators.

A, Ammeter reading $\frac{1}{20}$ – 3 and $\frac{1}{4}$ – 10 as.; B B, Bus bars; R, Return; T W, Trolley wire; S, Two-way switches; R A, Recording ammeter 2 to 25 as.; R V, Recording voltmeter 2 to 10 v.; L C, Leclanché cells; S P S, S. P. switch; E, Earth; P C, Three-way plug connections; P O I, P. O. indicator; C S P, Contact of sensitised paper.

Diagram of Board of Trade Switchboard.

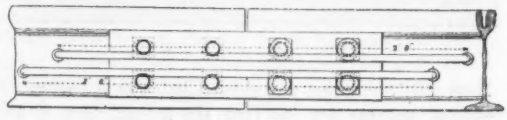
town terminus. A double track is mainly employed, though the narrowness of the streets necessitates occasionally a single track. At no part is the line an easy one to traverse. For some 700 yards from the Market Street terminus the gradient is not considerable, but the cars soon reach inclines which average 1 in 33. Half way up the line the steepest bit is encountered, the gradient averaging 1 in 15, which continues for over 200 yards. Though the remainder of the line is much easier, 1 in 17 and 1 in 20 are met till the level road which leads to Kingswood is reached. The highest portion



Combinations Effected by Series Parallel Controller.

of the line is some 300 feet above the Market Street terminus, showing how distressing the line must have been to horses. Though the track, as we have already mentioned, is in some parts a single one, the length of single line is usually so short, that a double trolley wire is used throughout, this being considered a more convenient method than breaking the continuity of the line.

A very remarkable feature of the line is the fine columns



Chicago Bond in Position.

that have been erected to carry the trolley wires. They have the reputation of being among the handsomest standards ever used for tramway work; certainly the design leaves little to be desired, and though they are painted in neutral colours to minimise their effect, they are most striking. We have reproduced illustrations which show the poles in position. Where the roads are fairly wide a double arm pole is

employed, but where the thoroughfares are too narrow to permit of this, the side pole with arms, varying from anything up to 12 feet, is used. It is the flexibility of the trolley that permits of these wide variations, but we shall have something to say of this later on. There is one point, however, that we should like to emphasise, and that is, under no circumstances are bearing wires used, the sole support of the wire being obtained from the poles. It is obvious, from the illustrations of the road, that there is very little interference with the traffic, nor is the appearance of the street up the line in a building that is on the site of the old horse depôt, the cars being housed in the same place. In describing the machinery of a power house, there is very little opportunity to be humorous, and to invest a mere description of plant with special interest would tax greater powers than ours. Nevertheless, there are some points of interest in the machinery room which are worth noting. Even the boiler house is more than usually interesting, the novel features being that the Vicar's stokers, which mechanically coal the two Adamson boilers of the Lancashire type, are driven by

Engineers and Staff who have Constructed the Line.

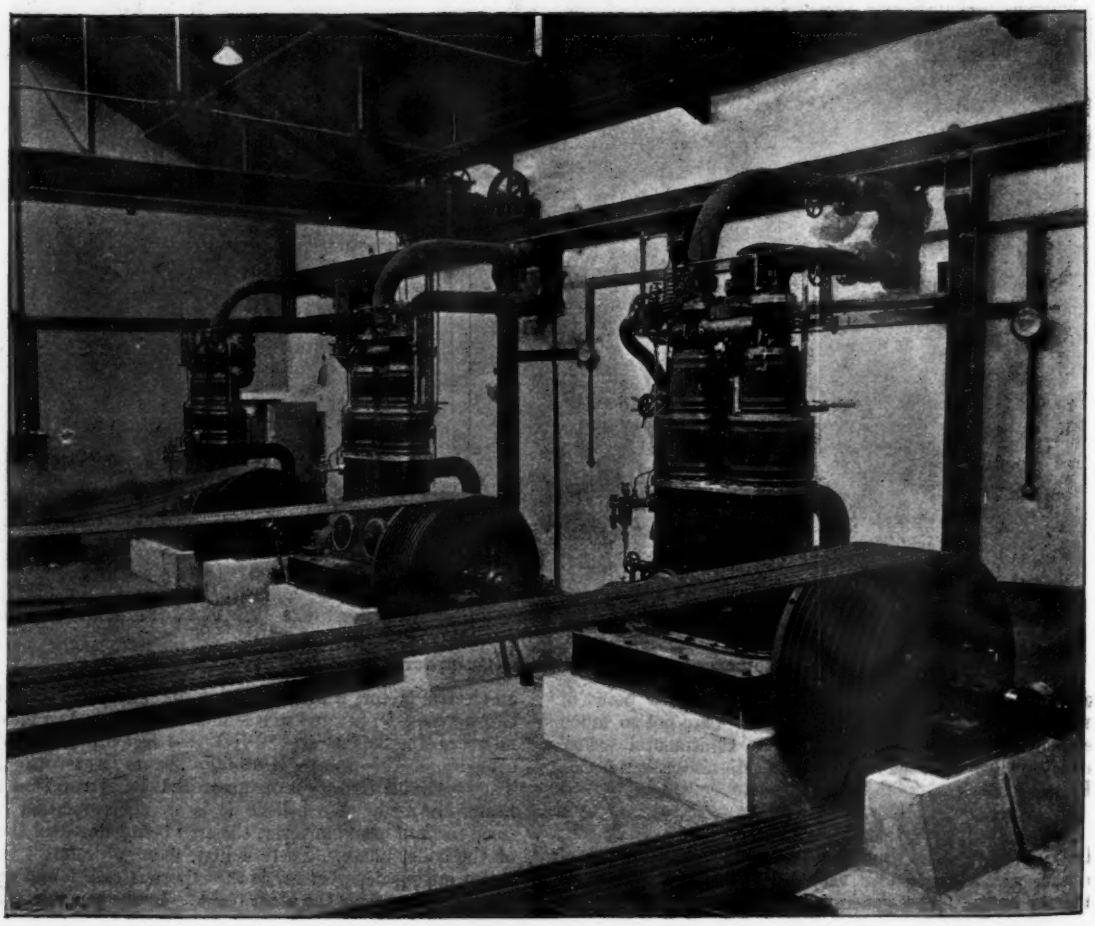
injured by the standards or the wires. It is a point of some importance, that at Bristol the wires are not so much in evidence as they are at many of the Continental towns. The poles have been made by Messrs. Morris Tasker & Co., of Philadelphia.

The Power House.

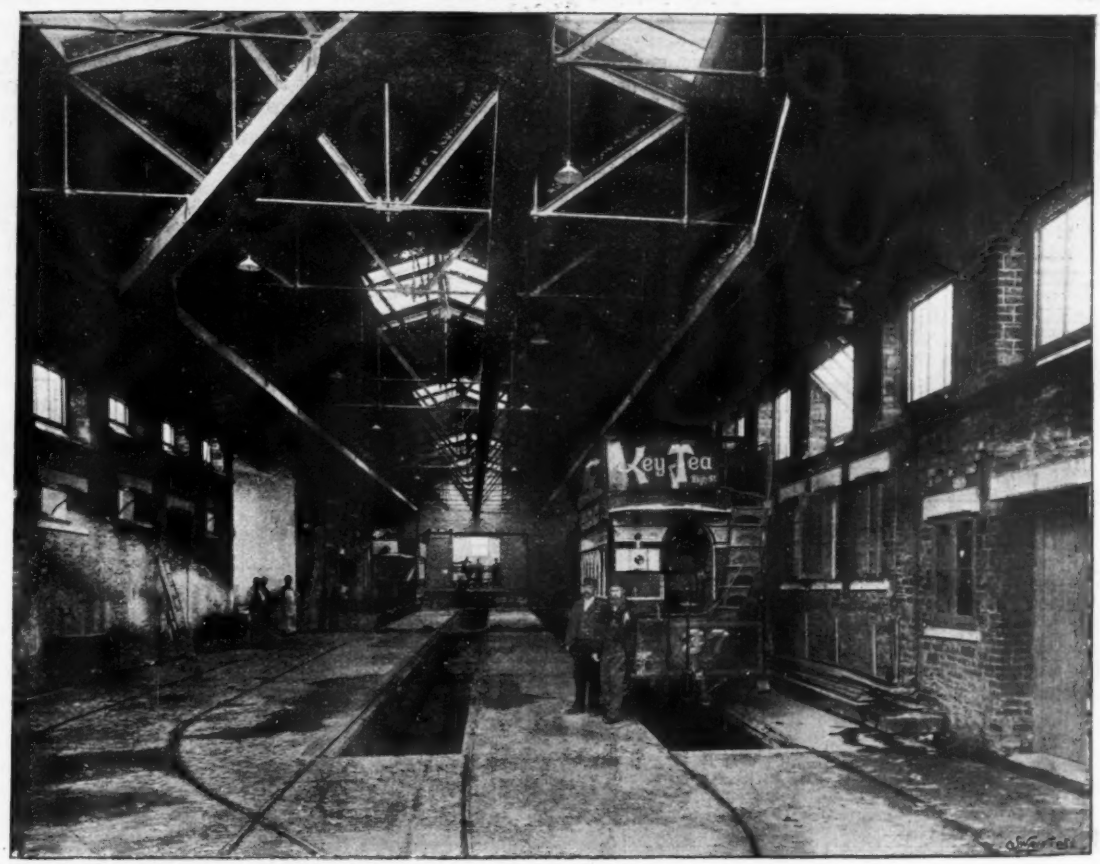
Leaving, for a short time, the interesting outside work of the line, we will consider very briefly the machinery at the power house. The generating plant is placed half way

an electric motor, while two Adamson pumps of the three-throw type are operated in a similar manner. The measurements of the boilers are 30 feet × 7 feet 6 inches, and the capacity of the pumps is 16,000 lbs. of water per hour. The inevitable Green's economiser and Berryman feed water heater are used. We believe it is in contemplation to use some form of coal conveyer, the coal being stored in the rear of the boiler house. There is little more of interest in the steam raising department, as the reporters call it, and we will proceed to consider the other plant. In the generating room

View of Dynamos.



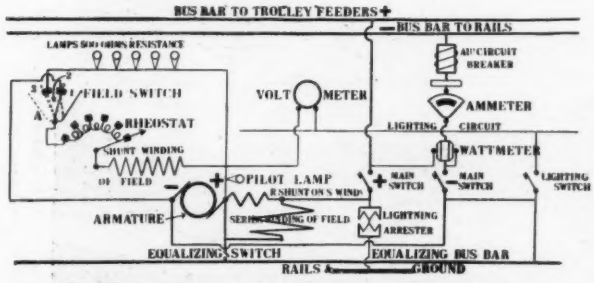
View of Engines.



View of Car Shed.

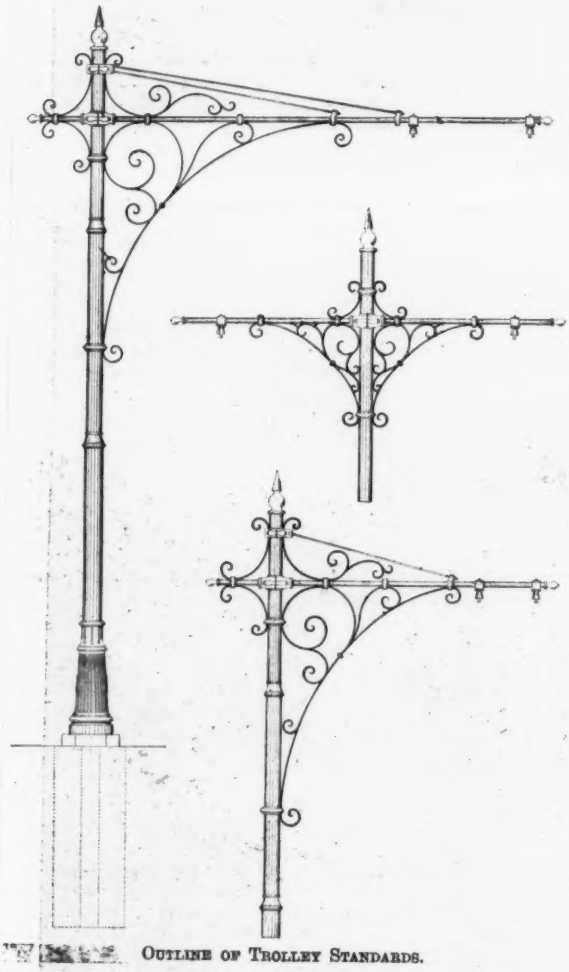
View of Market Street Terminus.

three Willans engines of the HH type drive multipolar continuous current machines made by the British Thomson-Houston Company. The engines give 135 I.H.P. at 380 revolutions per minute, with a steam pressure of 120 lbs. It is now almost a novelty to see Willans engines driving dynamos by ropes; in this case they drive the generators by means of 10 1¼-inch cotton ropes.



The Connections of One Machine to Switchboard.

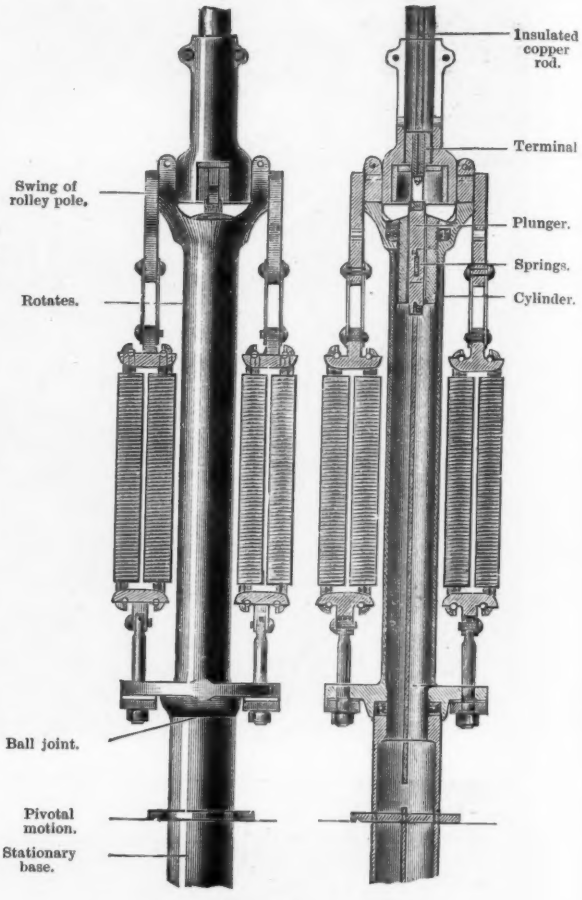
The electric generating plant consists of three slow-speed continuous current machines of the T.H. type, each of which is capable of giving 200 ampères at 550 volts at a speed of 650 revolutions per minute. The field magnets, which are compound wound, are of the four-pole type, and are mounted on a cast-iron bedplate. The armature is of



Outline of Trolley Standards.

the drum type. Each generator is fixed on sliding rails. For each of the three generators a lightning arrester is fixed on the switchboard; there is also a regulating resistance and switch for the machines, which enables the E.M.F. to be raised and lowered to the extent of 50 volts by the insertion of a resistance in series with the shunt windings of the fields.

The switches are carried on a board, which is made of black enamelled slate; it is placed 36 inches from the wall, thus making the connections fairly accessible.



Details of Trolley Pole.

The current from the machines is brought to an omnibus bar on the switchboard through a Weston ammeter reading up to 300 ampères. The dead beat character of this instru-

Trolley Pole.

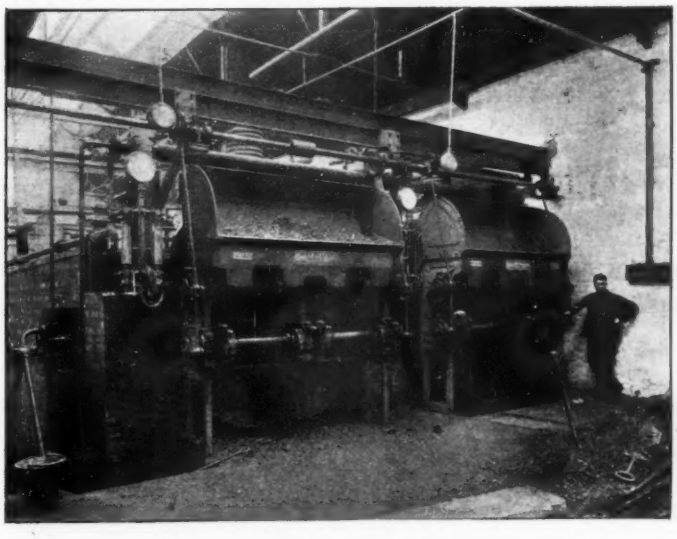
ment, by the way, was especially noteworthy. On the other side of the omnibus bar, between the bar and the feeders, a G. E. circuit breaker is fixed, which is capable of adjustment between 250 and 400 ampères. The instrument

appeared to us to be very reliable, and can be depended upon to go off within 2 per cent. of its setting. A peculiarity of the instrument is the report which it makes when breaking the circuit; it resembles that of a gun, and can be heard all over the room in spite of the noise made by the moving machinery.

The diagrammatic view of switchboard shows the connection of one machine to the board and its relation to distribution. The remainder of the switchboard is simply a repetition of this, with the exception of one panel, which is given up entirely to the purpose of making tests in accordance with the Board of Trade rules. As this is the first time that such a board has been made compulsory in this country, it will be interesting to refer to it.

The Board of Trade rules set forth that the potential difference between the furthest and nearest ends of a return shall not exceed 7 volts; it is also enacted that there shall not be a greater leakage than $\frac{1}{100}$th ampère per mile of tramway. There are, of course, other rules that have to be carefully borne in mind by the tramway engineer; but those mentioned are, perhaps, the most important. A test wire is connected to the extreme ends of the rails at Kingswood and Market Street, and brought to the special switchboard. Connection from the Market Street wire is made to a Pitkin recording voltmeter, which gives the difference of potential between the ends of the return conductors. Between the negative bus bar and the test wire which leads to the Kingswood end of the rail, six Léclanche cells and a sensitised paper polarity recorder are placed in circuit. The current from the Léclanche cells flows in the direction of the Kingswood end of the line, but if the difference of potential at the end of the Kingswood line were greater than 7 volts, then a current would flow to the power house, and the polarity recorder would show the direction in which the current was flowing. The arrangement for testing the difference of potential is clearly indicated in the drawing. For making the leakage tests the board is provided with two 50-ampère main switches, and a recording ammeter capable of reading from 2 to 25 ampères. The two switches are arranged to receive the conductors from the two earth connections, and on their other sides are joined up to an ammeter, which is connected to the negative omnibus bar. A current indicator is also provided, which indicates from $\frac{1}{20}$th of an ampère up to 3 ampères, and from $\frac{1}{2}$ an ampère up to 10 ampères, a switch being mounted on the instrument to alter connections, which will enable it to read in either ratios. The current indicator is connected up on one side to the earth connection switches, and on the other side has a portable connection to enable it to be temporarily placed in circuit with anyone of the generators when switching off from the main switchboard.

The tests that have been made by means of the foregoing arrangement show the line to be in an eminently satisfactory condition, and well within the limits allowed by the Board of Trade. On the occasion of a severe test, half a dozen cars bunched at the end of the line, the drop in voltage only amounted to $3\frac{1}{2}$ volts, while the leakage current was $\frac{1}{100}$th ampère for the whole length of line; this is an indication of the good conductivity of the return circuit, and serves to show that it is quite possible to comply with the regulations of the Board of Trade.



Boilers with Mechanical Stokers.

Bonding Operations.

Before leaving the generating room, we ought to mention that a motor generator, specially designed by Mr. Parshall, of the Thomson-Houston Company, is employed mainly for lighting the station, the output from the low tension side being 230 ampères at 135 volts. The primary terminals of the motor generator are connected to the station bus bar, and therefore receive energy at an E.M.F. of 500 volts.

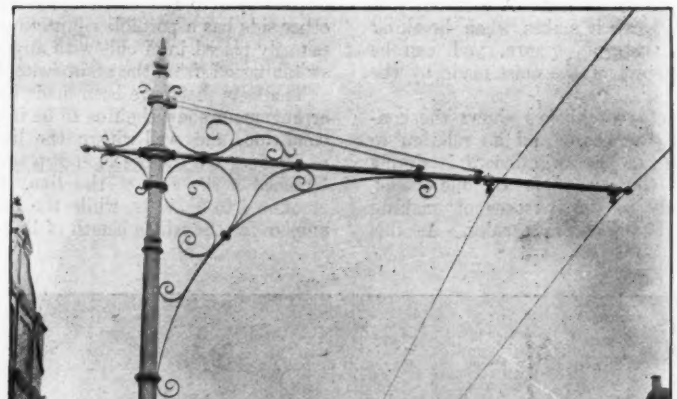
The use that is made of accumulators at Bristol is interesting. There are two sets, one of which does the necessary lighting of the station and car sheds, and the other set, which is divided into small units for the purpose of being carried on the cars for lighting purposes. The main battery consists of a battery of 55 cells of the chloride protected type, made by the Chloride Electrical Storage Syndicate; these accumulators besides being employed for lighting the works, can be utilised for charging the small sets of batteries, and, if necessary, current can be supplied to the low tension side of the motor generator, which would then give a high tension current available for driving the power house motors. Each set of batteries is placed in separate rooms. The smaller accumulators consist of 20 small sets, each one being made up of two boxes of five cells each. In the room set apart for the small batteries there are the usual measuring instruments; the connections being of a simple character, can be made by the car conductors.

Commodious workshops, test rooms, and offices are provided, and an idea of the roomy nature of the car shed can be seen from our illustration.

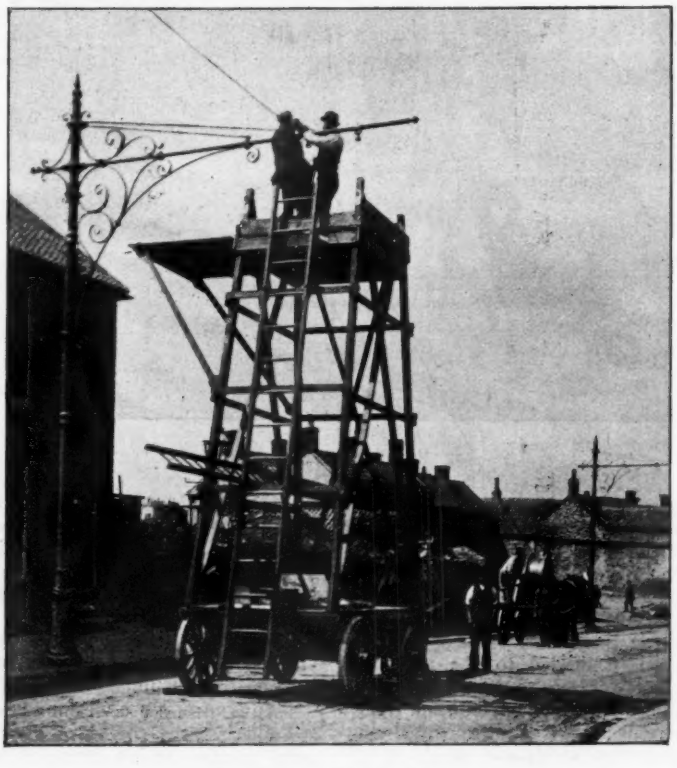
Arrangement of Feeders and Trolley Wire.

Following the course of the current from the power house to the trolley wire, it will be seen, by aid of

the drawings, that the current is carried by two feeders to the various sections of the line. The feeders consist of heavy armoured cable of the Silvertown type, being ·15 square inch section. At every half mile the feeder is carried into a junction box, from whence the line is fed. In the junction boxes are two rows of terminals, the bottom row being joined together. The outside terminals are those by which the feeders enter and leave the box; those for intermediate terminals represent four sections of the trolley wire. A sectional drawing of junction box shows cables and terminals with one plug in position. The trolley wire, being a double one, it is obvious that one junction box controls two half miles of wire on each side. A reference to the plan of feeders and trolley wires will show that if the outside terminals are connected across, the bottom bar is in circuit with the feeders; but before the trolley line can be made alive, it is necessary to bridge across from the lower to the top terminals. This is done by means of knife edge switches, shown in the section of junction box. If all the terminals are thus bridged across, the four sections of trolley wire are being fed with current, the isolation of each section being effected by simply taking out the switch corresponding to the section, while there is no interference with the other sections. In the lower half of the junction box is a lightning arrester and telephone set, which is in connection with the other boxes and the power house; the wire for the Board of Trade tests is also brought into the box, this and the telephone wires being in one strand, insulated and armoured. The sections of line are kept apart by a special form of sectional insulator, which we shall refer to when speaking of the details of the line. For the most part the junction boxes, which are about 3 feet in height, are placed at the edge of the pavement, though the Market Street terminus box is placed in the tramway waiting room. Exteriorly they are nothing more than iron boxes, which, being painted dark grey, are scarcely noticeable.



View of Single-Arm Trolley Pole.



Erection of Trolley Wire.

The return circuit is made solely through the rails, but from the excellent results obtained on the Board of Trade switchboard, it is very evident that the bonding of the rails must be of great excellence. The track was, of course, entirely relaid, a much heavier rail being necessary; it weighs 76 lbs. to the yard, and has unusually heavy fish-plates. The electrical connection is made by means of what is known as the Chicago rail bond. We need scarcely mention here what is necessary to make the rails as good a conductor as possible. Great intellects have gone to pieces on the return circuit question, and it is desirable that we should avoid in England the waste of talent that has gone on in other places. The bond, then, which is employed at Bristol, is a copper rod, having tubular or thimble-shaped terminals bent at right angles. These terminals are inserted into holes specially drilled in the rails; there is then inserted into the terminals drift pins, which, being slightly larger than the apertures, have the effect of expanding the openings, the contact with the rail being then as near perfect as possible. It would seem that electrolytic action would be almost impossible under such circumstances; the experience at Bristol with these bonds will be worth noticing in a year's time. For $1\frac{1}{4}$ miles on each side of the power station the line is double bonded with two 3/0 Chicago bonds to each rail,

the two ends of the line being only single bonded. The return current is brought from the track back to the negative bus bar by old rails equivalent to a section of 300 lbs. per yard bonded with eight 3/0 bonds.

The Rolling Stock.

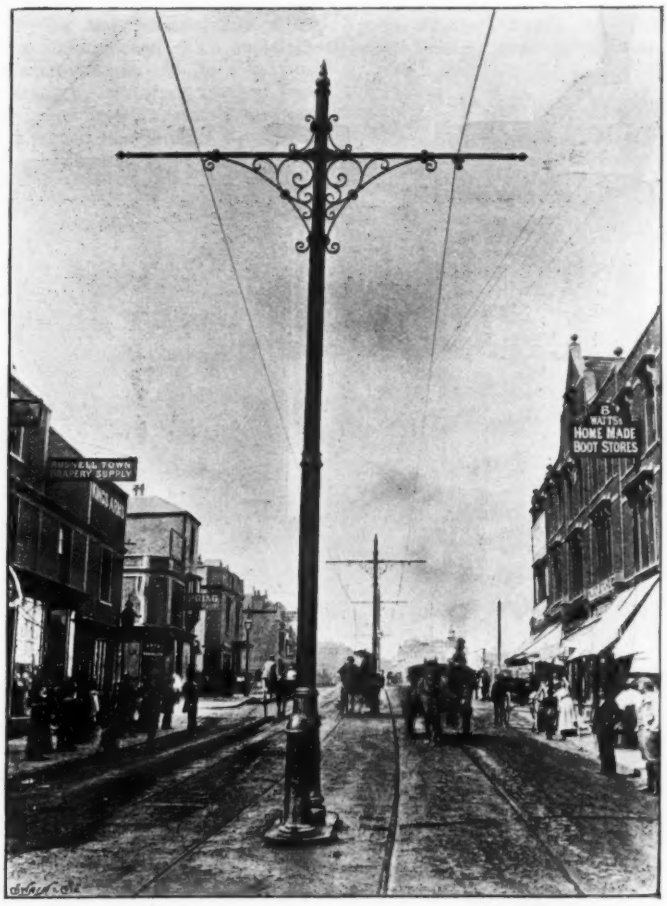
The bodies of the cars, of which there are 12 fitted with motors, have been built by Messrs. Milne & Co., of Birkenhead. The most noteworthy point of difference between them and horse cars, apart from the electrical equipment, is the extreme length of platform at each end; this special form has been necessary in order that the driver and his controlling apparatus may be clear of the steps. It will be seen from our illustrations that, following the usual practice on English cars, outside seats are used; this is interesting because it shows that there is no difficulty in arranging the trolley pole to fit in with English methods. Outside seats are so uncommon on the electric roads of America and the Continent, that it is worth while noting the difference. The cars carry 18 persons inside and 26 on the roof; the length inside is 12 feet 9 inches, the length of the platform being 24 feet. The height of the roof is 9 feet 6 inches from the rail level.

The car bodies are placed on cantilever trucks made by the Peckham Motor Truck and Wheel Company, which are so much used in the States. It might be mentioned here that these trucks, as well as poles, standards, wire, and generating machinery, have been all sent from the United States. The occasion has afforded our American friends an opportunity of showing what their good work is really like.

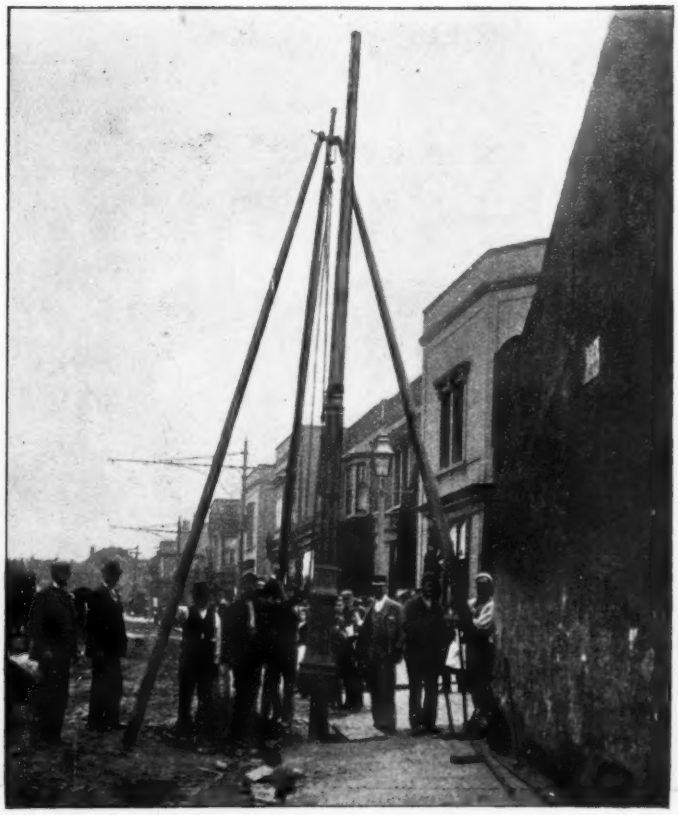
There are two motors on each car; they are supplied by the British Thomson-Houston Company, and are of the "G. E. 800" type. This motor is, of course, not common in England, but it is nevertheless fairly well known. A full description of this particular type appeared in our issue of December 7th, 1894. The power of the motor used on the Bristol lines is a tractive effort of 800 lbs. at the periphery of a 30-inch wheel. The motor is hinged on the axle, and flexibly supported at the opposite end. Single reduction gearing is employed, the ratio being 4·68 to 1. As is usual with this motor, all the working parts are enclosed in a dust and water case. With the exception of the hand brake, the controlling of the car is done by means of a General Electric Company's (America) K controller. This controlling device is perhaps one of the most interesting apparatus that is used in electric traction; it includes in itself the accumulated experience of years, and it is not surprising that it should have been so widely adopted.

The K, or perhaps better known as the series-parallel controller, comprises practically a regulating device, as well as motor, cut-out and reversing switches. We show the apparatus open. It is placed in an upright position at the end of the car, and takes up very little room. It is, of course, operated by a handle, which turns the spindle and makes the various combinations indicated by the position of the handle. One of the most striking features in the controller is the use that is made of the magnetic blow-out for the arc, which forms on making circuit. A drawing is given which shows the various combinations that can be effected by means of this device.

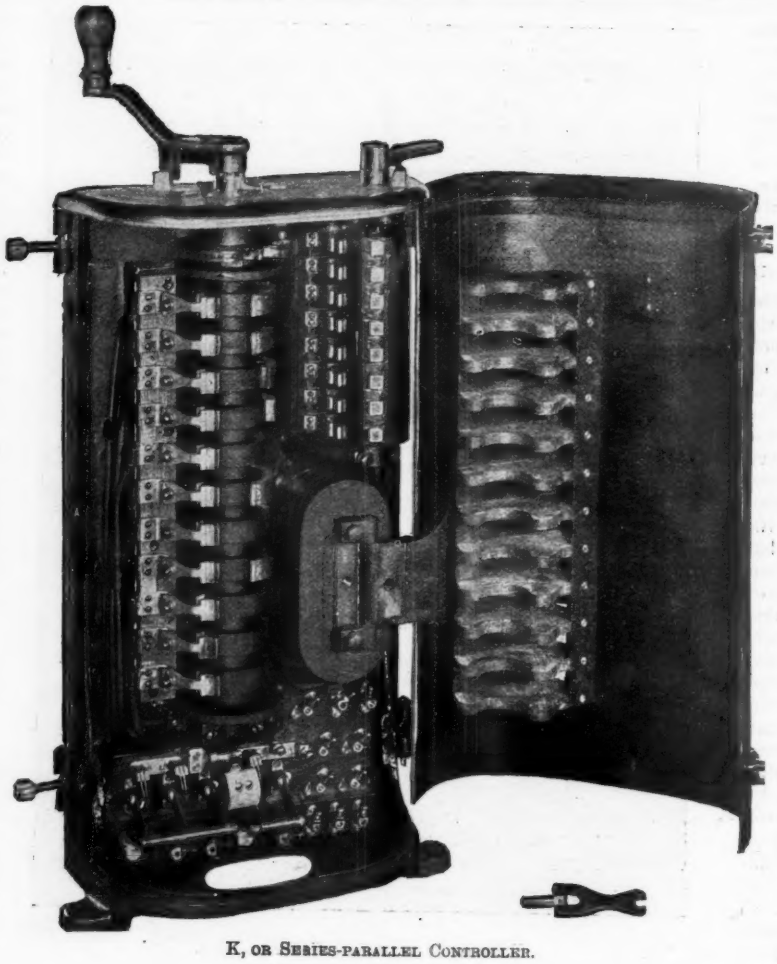
The lighting of the cars is practically done by two systems. Of course, one of the easiest ways to light an electric car is from the trolley wire; but



View of Double Arm Trolley Pole.



Erection of Standards.



K, or Series-parallel Controller.

First Car Run on the Line.

the inconvenience of this arises when the trolley leaves the wire, or the machinery at the power house stops, the light in the cars being extinguished. To avoid the disadvantages of such an arrangement, the lighting from the trolley wire is supplemented by the light derived from the small sets of chloride accumulators which we have mentioned. The lighting from the line is done by placing five 16-C.P. lamps in series, the lamps supplied by the accumulators being of 20 volts.

The Trolley.

The feature of special interest in the electric car—and, indeed, in the whole system—is the special form of trolley that is used. One of our contemporaries has called it of the

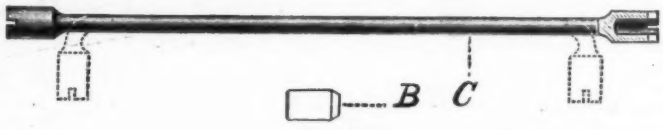


Fig. 14.

Fig. 10.

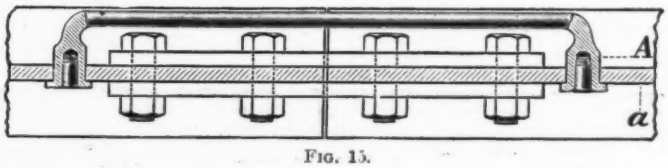


Fig. 15.

Fig. 12.

Fig. 8.

Fig. 13.

usual American type; but, so far from it being of any type, it may be said that the form has been used only once before, and that was on the South Staffordshire tramway, when the side trolley was employed for the first time. When we described the South Staffordshire electric tramways some three years ago, we drew attention to the far-reaching improvement in overhead lines that had been attained by the system due to Mr. Dickinson. It is interesting to note that the value of the principle is admitted by the engineers for the line at Bristol, who, with certain modifications, have adopted the system.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

The modifications consist in making the trolley pole somewhat simpler than the one at South Staffordshire. At the same time, it must be admitted that the trolley is not so severely tested on the Bristol line. It is, however, a wonderfully flexible arrangement, and will permit of a variation up to 8 feet from the centre of the car. The trolley is mounted on a base, which stands 6 feet above the car roof; in this base the trolley is free to revolve, thus giving the horizontal motion. The vertical motion is gained by a plunger and cylinder arrangement, springs attached to the top of the base controlling the amount of movement. A clear idea of this will be obtained from the detail drawings. There runs from the trolley wheel down into the base an insulated copper rod, which conveys the current to the motors.

Fig. 7.

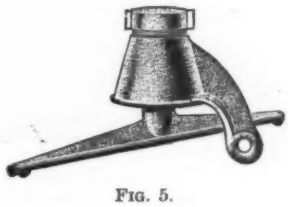


Fig. 5.

Fig. 9.

It ought to be mentioned that the trolley pole is insulated, and the chances of passengers receiving shocks are very remote.

Some Details of the Line.

We are giving some of the details of the line construction, because besides being new, they also show how mechanically strong are those portions of the line which have to bear the greatest strain. Fig. 1 shows the form of bracket arm hanger, which has double insulation; indeed, double insulation is used throughout the line. The hanger is that known

as the West End type, the castings are of bronze, while the insulation is that known as the Ætna, the precise nature of the insulating material being a manufacturer's secret. Figs. 2, 3, and 4 show the various forms of cars used for straining and splicing purposes. Fig. 5 is a form of single "pull off" used at curves, and fig. 6 is an insulating bolt. The section insulator, which is used at every half-mile of trolley wire, shown in fig. 7, is practically a combination clamp; the

Fig. 11.

Fig. 6.

middle portion of the device is of wood, and can be renewed while on the line. A clamping device allows of the coiling of trolley wire on the top of the insulator, which can be let out to repair the line in case of a break. Figs. 8 and 9 are forms of aerial frogs and crossings. Fig. 10 is an insulator used for the frogs. Fig. 11 is an example of insulators used in the car shed, while fig. 12 shows the Brooklyn strain insulators used at terminals and points where strains have to be met. The whole of the foregoing material, as well as the "Ajax" lightning arrester, has been supplied by the Anderson Line Material Company.

till that time arrives. Each fuse is provided with two soft rubber plugs, which allow the free ends of the wire to pro-

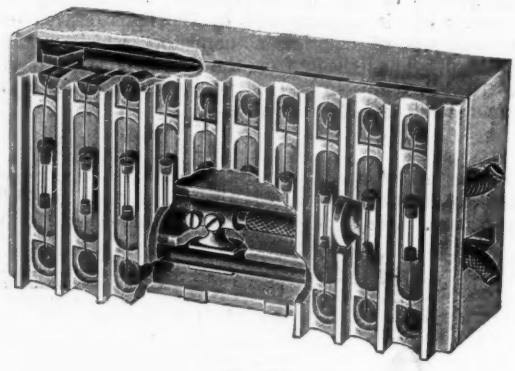
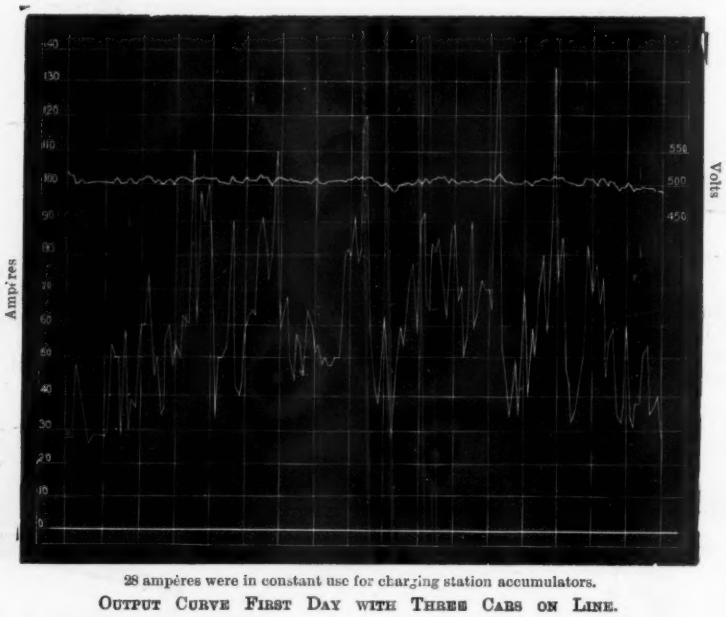


Fig. 13A.

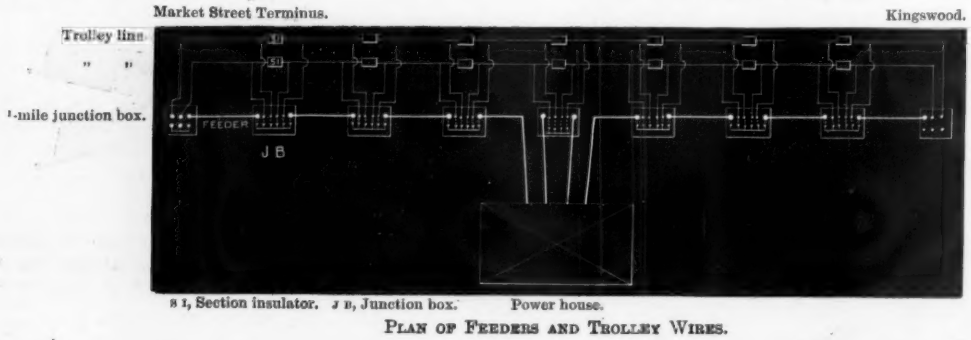
ject through the cover into the channels of a porcelain box which contains the carbon terminal rods. Loose pieces of carbon, shaped like wedges, connect the free ends of the upper fuse to the carbon terminals, and in this position the arrester is ready to be placed in circuit.

Figs. 14 and 15 are the details of the Chicago bond, which we have already described.



28 ampères were in constant use for charging station accumulators.

Output Curve First Day with Three Cars on Line.



S I, Section insulator. J B, Junction box. Power house.

Plan of Feeders and Trolley Wires.

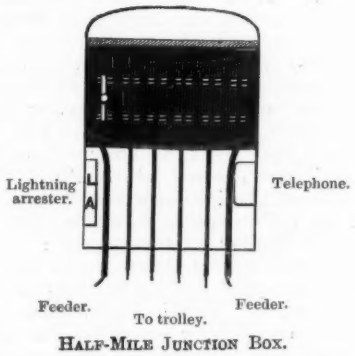
The "Ajax" lightning arrester, figs. 13 and 13A, which is placed in each junction box, consists of a pair of fine brass wires with $\frac{1}{20}$th of an inch air gap between them. These wires form the dischargers, and are held in position by pellets of high resistance wax. A small glass tube is hermetically sealed over the dischargers to keep them clean and dry, and as they will be only called upon to act once, they will remain in good condition

General.

Trial runs have been made continuously during the past fortnight, and there is little doubt that when the system is formally inaugurated, the plant will be in good working order. The Board of Trade inspection took place a few days ago.

The local interest in the line is most profound, and takes

at times very curious forms. We stood one night amongst a crowd that were witnessing some slight repairs on the line, necessitated by a driver in his pupilage. There were divers opinions set forth to account for the repair. Two diminutive youths hugged a theory to themselves that it was all due to leakage, others inclined to the view that personal error was responsible. Severe criticisms, ornamented by language more forcible than picturesque, were passed on all connected with the tramway; but a resumption of the trials did much to mollify them. The spirit of criticism, however, led them on all occasions to collect round the closed doors of the depôt; they conceived it their duty to the tramway company to sit up late at night, and the small fry of the neighbourhood tried hard to test the fenders of the cars. So keen were the residents on the subject of electric traction, that some circumspection was necessary, in order to make the first run in comparative quiet. It was made shortly after midnight.



Half-Mile Junction Box.

The good people of Bristol had scarce entered into their first sleep when a glaring light streaked across the bedroom windows. They realised that the company were stealing a march on them; up went windows and out went heads, and there was the first car gliding down the street. That part of Bristol which is traversed by the electric cars immediately got up and waited for the return of the surreptitious car. Never was an electric car awaited in this country by a scantier clad concourse; no accidents happened, however, and the first run was as successful as we hope all the others will be.

The British Thomson-Houston Company are the contractors for the whole of the work, and Messrs. Kincaid, Waller and Manville are the consulting engineers.

CORRESPONDENCE.

Electric Lighting in Spain.

I read with surprise your remarks on page 371 of the current number of the Electrical Review, under the heading "Electric Lighting in Spain," and am sure you will not hesitate to rectify what is liable to convey to your readers an erroneous idea of the existing state of electrical enterprise in this country and can only have been inserted in your usually well-informed periodical by inadvertence.

Far from "possessing less enthusiasm in electrical matters than any other continental country," as your paragraph says, Spain is perhaps the nation which has most readily taken up the question, and the town which is not provided with electric light is rather the exception than the rule. Unfortunately I have not complete statistics at hand, but I have, and shall be pleased to forward to you, sufficient to prove that 48 per cent. of the towns of over 10,000 inhabitants possess installations, a proportion which I think can challenge comparison with the British Isles.

Spanish customs differ essentially from English; hence, perhaps, the impression derived from the public announcements by the municipalities, to which you refer. These invitations to tender have, in reality, little significance and are merely a formal compliance with the law, by means of which the Municipality must, before handing over the lighting of a town or any other contract to a private body, submit the matter to public competition. Before the publication of these invitations with regard to electric light, private enterprise has in almost every case laid the line for ordinary lighting purposes and secured all probable subscribers, so that the possibility of competition for public lighting alone is remote—and as a rule the Municipality comes to terms, after advertisement, with the constructing firm. That is not the stage for competition but months before, and when the schemes are projected there are plenty of foreign and Spanish houses in the field.

It is true that we have few firms *manufacturing* electrical plant in Spain, but it is equally so that the firm which does most business in the country is Planas and Flaquer—a purely Spanish house and at the same time a constructing house. Next in importance, as regards business done, come the German and Swiss firms. The A.E.G. and Siemens and Halske are said to find Spain the second market of the world; and "Oerlikon" count with some 200 installations finished and in construction here. In the third rank are Austrian, French and Belgian houses, and it is owing to their inability to compete with the foregoing that English firms are so little represented, for with a wide experience, I can only recall two or three instances of English work here—Mordey's alternators in Legovia, and an installation by Siemens Brothers, now being concluded in Alicante. There was keen competition for an installation (800 H.P.) recently in Valladolid, and though Crompton & Co. tendered amongst others, the contract was secured by "Oerlikon."

The Deva case to which you refer was settled six months ago, no less than five firms tendering, but that is only one of many cases in which the public lighting is afterwards offered to public competition to comply with legal formalities.

It is well that English contractors should come to Spain, and they will be welcome, for, if we "lack energy" we have learned that competition lowers prices; but they must not come thinking that "not a single Spanish contractor" will oppose them—there are 16 firms in Madrid alone engaged in installation work.

Luis de la Peña,
Editor *Madrid Científco.*

October 2nd, 1895.

Another Remedy for Electrolytic Corrosion from Street Railways.

Under the above heading in your last week's issue appears an account by Mr. Gray of a system which is claimed by Mr. Farnham as not having appeared in print before it appeared in the August number of *Cassier's Magazine.*

Mr. Gray points out that a similar system was described in the Electrical Review in June.

Mr. Gray and Mr. Farnham will also find it described in the discussion on Mr. Wilkinson's paper, read before the Electrical Engineers in November, 1894, and published in the *Journal* of the Institution in January, 1895 (page 750, Vol. xxiii.)

B. M. J.

October 4th, 1895.

The Paralleling of Compound Dynamos.

I am engaged in running two new compound dynamos for incandescent lighting, in parallel, by means of the "Gramme connection" across the positive brushes, and though the dynamos are supposed to be identical in design, they do not share the load equally.

Could you refer me to any articles on the subject in past numbers of your valuable paper; or, perhaps, one of your correspondents would detail some of his experience under like circumstances, if you think it of sufficient public interest to print.

O. V. G.

October 3rd, 1895.

Professional Etiquette and Commercial Morality.

A few weeks ago I read with considerable pleasure an article in your valuable journal condemning the methods of obtaining clients which have been adopted by certain consulting electrical engineers. Your observations have not come

too soon, and I regret to see that you have not continued them in your more recent issues.

The Institute of Electrical Engineers will certainly lose all credit if it cannot expel such men as you refer to, and the necessary powers should be at once obtained and rigidly enforced. Almost daily we hear of corporations passing over those men who are recognised as the most eminent in the profession in order to retain engineers who are more capable of judging the champagne capacity of the town councillor than of drawing up the simplest specification without the aid of their pet contractor, and that contractor (*mirabile dictu*) usually gets the work.

I sincerely trust that something more will be heard of this matter, and in the meantime both the profession and the trade should withdraw all support from a journal which allows its representative to tout either for contractors or for contractors in the guise of consulting engineers.

H. R. Young.

Clapham, *September 30th.*

Compounding Dynamos by Armature Reaction.

In reply to Prof. Elihu Thomson's letter in your last issue, the sentence Prof. Thomson quotes, of course, shows clearly that he appreciated the fact that the armature magneto-motive force breaks down the flux from the wound poles; but in a previous paragraph he says: "The final breaking down is doubtless due to the saturation of the forward portions of the dead poles, together with the armature core projections, &c." It therefore appeared to me that he did not regard the final breaking down of the electromotive force of the armature as due to armature reaction.

The loss due to resistance of winding and brush contacts, &c., was apparently the main cause of the breaking down in Prof. Thomson's experiments, as recorded in the curves reproduced from his paper, the bending down of the curve, fig. 8, which begins at about 250 ampères, being, I imagined, due to overpowering armature reaction. The point which I thought Prof. Thomson did not bring out clearly is that after a certain load is reached, the armature reaction, in his arrangement, does not tend to increase the effective flux, but to diminish it. Referring to his fig. 11, it is, I think, clear that the curve of potential around the armature must have passed below the zero line instead of curving off as shown. This I have ventured to represent. See dotted continuation in fig. 11, below.

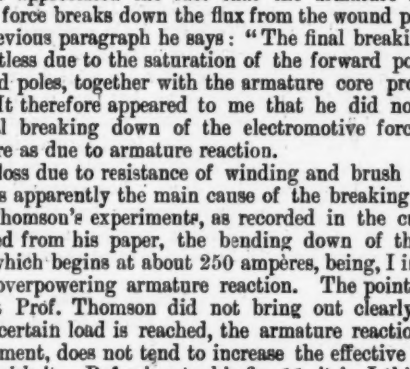


Fig. 11.

Prof. Thomson's remarks about the difficulty experienced in obtaining exact results no doubt account for the absence of this part of the curve in his fig. 11. With regard to the second part of Prof. Thomson's letter, I certainly overlooked the fact that he was referring to the effect of giving the brushes a backward lead in a machine having as many sets of brushes as poles. I thought this was so well known as not to need restatement. So long as the brushes had a backward lead (this, I now see, is what Prof. Thomson means when he says, "while maintaining the brushes near the forward edge of the poles"), however, the machine would tend to excite without winding on the magnets, whether there were one or two poles between the brushes, or to compound, if one or both poles were separately excited or provided with shunt coils.

There is a further point in Prof. Thomson's paper on which I made no comment in my article in your issue of August 30th; but, with your permission, I will now do so, hoping that Prof. Thomson may be able to throw additional light on it for the benefit of your readers. Prof. Thomson says:—"A feature of the machine which developed itself when carbon brushes were used was that even at heavy loads the brushes could be set back from their maximum position—or true diameter of commutation in this case—and that the movement was attended with little, if any, increase of spark, *while the potential steadily went down.*" (The italics are mine.) I can only understand the amount of sparking remaining the same on the supposition that the fall of potential, and, consequently, of current, was sufficient to account for it. Degrees of sparking, however, it is well known, are exceptionally difficult to observe when carbon brushes are employed, and I hope Prof. Thomson will pardon me if I suggest that possibly this observation would not be confirmed if the experiments were repeated. The point of real interest is, however, the fall of potential, since moving the brushes backward (*i.e.*, against the rotation), should, theoretically, first decrease the demagnetising turns of the armature, and then, if carried far enough, bring direct magnetising turns into play, whether the machine were of the ordinary type, or such as Prof. Thomson describes. While experimenting with the machine described in my paper "On the Prevention and Control of Sparking, &c." (see *Journal* I.E.E., Part 107, vol. xxii., page 384), I found that inductive commutation, if I may so describe it, was quite essential to the machine being self-exciting without winding on the magnets; in other words, if the brushes were shifted either way, so as to bring the commutating coils out of position relatively to the pole tip, the excitation failed. This is clearly shown in diagram, fig. 9, which accompanies my paper above referred to. Now, when the brushes were shifted backward, as described by Prof. Thomson, there would be no inductive commutation; the current in the armature sections under the brushes remaining unchanged, or being even greater than the half-armature current, until the preceding section was almost out of contact with brush, when it would be suddenly reversed by the increasing resistance due to the break. This process would evidently involve considerable waste of energy, and in an armature of large self-induction the cumulative effect, I think, supplies the explanation of the results observed by Prof. Thomson, and also by myself.

W. B. Sayers.

October 5th, 1895.

Localisation of a Fault by Kennelly's Method.

In the particular case referred to by Mr. Cann, the formula quoted is in itself a very simple one. For if the numerical value of $\sqrt{c_1} = 2$, and $\sqrt{c_2} = 1$, then the equation

$$x = \frac{R_1\sqrt{c_1} - R_2\sqrt{c_2}}{\sqrt{c_1} - \sqrt{c_2}}$$

becomes $x = 2R_1 - R_2$.

This, of course, gives exactly the same result as the method suggested by your correspondent.

W. J. M.

In my letter of the 4th inst. bearing on this subject, the following correction should be made:—

Under heading "Example 1.—Third Test."

With 20 cells $c_1 = 697$ divs. $R_1 = 3{,}134\ \omega$.
With 80 cells $c_2 = 186$ divs. $R_2 = 3{,}147\ \omega$.

This should read

With 80 cells $c_1 = 697$ divs. $R_1 = 3{,}134\ \omega$.
With 20 cells $c_2 = 186$ divs. $R_2 = 3{,}147\ \omega$.

Herbert E. Cann.

Portrush Electric Tramway Board of Trade Inquiry.

In your issue of 4th inst. you state that I gave it as my opinion "that 290 volts was dangerous to human life." Permit me to say that I never laid down any such principle; the words I used were: "There was possible danger to human life."

A. E. Porte.

Dublin, *October 9th*, 1895.

BUSINESS NOTICES, &c.

Business Announcement.—Mr. G. F. Kenyon informs us that he has given up the business of Rigg, Kenyon & Co. at 9, Swaine Street, Bradford, and is now managing director of the Automatic Electric Sign Company, Limited, who are carrying on business at his old address, they having taken his business and patents over.

Change of Address.—The Epstein Electric Accumulator Company, Limited, informs us that owing to a large increase in business it has been found necessary to remove the head offices from Gresham House to more commodious premises at Victoria Mansions, 28, Victoria Street, London, S.W., to which communications in future should be addressed.

Bankruptcy Proceedings.—The last day for receiving proofs in connection with the intended division in *re* Walter Andrea (carrying on business as Walter Andrea & Co., in London, as electrical engineers) is October 23rd. Mr. G. Wreford, the senior official receiver, of Bankruptcy Buildings, is trustee.

The statutory meeting of the creditors interested under the failure of D. J. Whatmough (J. & P. Dyer, and formerly as W. Mason), lately carrying on business at the Market Place, Oldham, as electrical engineer, draper, &c., took place at Oldham on the 3rd inst. under the presidency of the District Official Receiver. After discussion, Mr. J. Jones (of Mountain, Jones & Co.), was appointed trustee, and a committee of inspection was also appointed.

Dissolutions of Partnerships.—Messrs. F. Woolstone and W. Nottingham, formerly carrying on business as electrical engineers at Black Bull Yard, Lands Lane, Leeds, as Woolstone and Nottingham, dissolved partnership by mutual consent as and from the 27th August. All debts will be attended to by F. Woolstone.

Messrs. C. H. Smeeton and H. Page, carrying on business as electrical engineers at 63, Queen Victoria Street, London, as Smeeton and Page have also dissolved partnership by mutual consent as and from the 19th September, 1895. All debts will be attended to by Herbert Page.

Electric Construction Company.—As would be gathered from the remarks made by Sir Daniel Cooper at the meeting of the company held a few weeks ago, the Electric Construction Company are advancing the prices for their standard sized continuous current dynamos. They are now circularising the trade to this effect, stating that the advances are due to the higher cost of materials and the improvement in trade prospects. A new catalogue has been issued containing these revised quotations.

Electric Light Ladders.—There has just been supplied to the Edinburgh Corporation a fifth of Mr. J. H. Heathman's patent ladder towers for use in connection with the electric light installation. Others have just been despatched to Bath, Blackburn, and Southport.

Fire.—From the daily press we learn that on Sunday morning firemen were called to 91, Onslow Gardens, South Kensington, where it was found that a transformer had taken fire in the vault under the pavement at the private residence of Mr. A. Hughes. The fire was soon overcome.

Price Lists.—Messrs. C. H. Cathcart, of London, E.C., have sent us copies of their new price sheets of mill and factory fittings, and table standards. Both sheets are illustrated and priced.

From the United Asbestos Company we have received a copy of their new catalogue. Among a variety of asbestos and other articles mentioned, we notice special features are made of the "Victor" metallic joints, "salamander" joints, "gladiator" packing, and their new asbestos patent "salamander" embossed decorations.

Messrs. B. Verity & Sons have just issued a neat publication which contains a list of the principal electrical works carried out by them. There is a lengthy list of the notable personages, including statesmen and others for whom they have done work, also a note of the clubs, public buildings, banks, country and town houses, hotels, &c., which have been fitted up by them for electric lighting. An illustration is given of the Blackpool Tower which Messrs. Verity supplied with several thousand lights, and a few particulars are included of the firm's electric motors for pumping and laundry work.

Pink v. Cambridge Electric Supply Company, Limited.—In the Cambridge County Court on 25th ulto., Judge Bagshawe and a jury had before them the case of Octavius Frank Pink, chief assistant in the Cambridge Free Library, *versus* the Cambridge Electric Supply Company, claiming damages for an accident which he contended was due to negligence on the part of the company in connection with the laying down of its plant. Plaintiff claimed £20. In his evidence plaintiff stated on May 27th last, while walking from the Free Library, the inside of his heel caught against one of the electric light boxes, and he was thrown heavily to the ground. He was injured below the kneecap and suffered pain and inconvenience, and had lost money owing to his inability to travel the following day. The box, he stated, was half an inch above the level of the pavement, but it was not so high now. Evidence for the plaintiff having been called, the defence was opened. It was claimed that the accident occurred through Mr. Pink's own want of caution. The box was now in the same position as on May 27th. The defendants were only responsible for any accident that might have occurred in consequence of the boxes being improperly laid down. The Corporation repaired the pavement, and it was the duty of the Corporation to keep the pavement at such a height that the boxes should not be above it. If, however, the Company was liable, he submitted that the claim for damages was a most exorbitant one. After further evidence had been given, the judge and jury viewed the box. His honour summed up, setting forth certain questions for the jury to consider in coming to a decision. A verdict was found for the defendants, and judgment was entered accordingly with costs.

Plant for Sale.—From our advertisement supplement will be obtained details of electric lighting and other machinery, including gas engines, dynamos, switchboards, shafting, pulleys, &c., which is offered for sale. Particulars from Messrs. Henry Lea and Thornbery.

Sell's Directory of Telegraphic Addresses.—We have received the third and final supplement to this directory for the year, which corrects the information supplied to him by the Postmaster-General during the past three months. We are asked to state that all the additions and alterations contained in the three supplements of the year and all further corrections and information received from the Post Office during the current three months will be incorporated in the new volume for 1896, which will be ready early in January next. We observe an interesting and useful table at the commencement of the present supplement giving a list of the towns between which telephonic communication can now be made, also the various charges for such communication.

The Electrotherm.—In our issue of August 23rd we gave a few particulars of the "Electrotherm," a new invention which is having great success in the United States. Messrs. Witty and Wyatt, Limited, of 88, Leadenhall Street, E.C., are the sole European and Colonial agents for the apparatus, which has been thoroughly tested and approved of by the Electrical Standardising, Testing, and Training Institution.

The Lithanode Electric Storage Company, Limited.—We have notified in our recent "Official Returns" certain changes that had taken place in this company. Mr. J. T. Niblett, the late general manager of the Lithanode and General Electric Storage Company, Limited, in conjunction with friends, has formed a syndicate for the purpose of carrying on the business of electrical engineers and instrument makers; to further develop certain specialities in instruments, testing and medical batteries, also in artistic and temporary electric lighting. Mr. Niblett has completed (by order of the Court) the purchase from the liquidator of the Lithanode and General Electric Company, Limited, all the patents, the goodwill, plant and stock-in-trade, as a going concern, as and from July 8th last, and in future he and his friends will trade under the style of the Lithanode Electric Storage Company, Limited. They have taken over the old company's works at Westminster, where, until more suitable offices and showrooms are secured, all communications should be addressed. The new firm will continue the manufacture of the now well-known lithanode batteries, &c., as made by the old company, in addition to the specialities mentioned above. With adequate working capital, and the increased facility of manufacturing, there should be considerable development in business. Considering the valuable patents possessed by the company, it ought to attain success, and we sincerely trust that it may.

ELECTRIC LIGHTING NOTES.

Aberdeen.—The officials of the Free Bon-Accord Church desire to introduce electric lighting there. This will require extension of mains, and the Electric Lighting Committee of the Council are considering the application.

Barmouth.—An electric lighting scheme for Barmouth is in hand. The Barmouth and District Electric Lighting and Power Company intend to apply for a provisional order.

Belfast.—At the last meeting of the Electricity Committee, the engineer, Mr. V. A. H. M'Cowen, submitted estimates of the cost of the proposed extension of mains in Arthur Street, Howard Street, College Square North, College Square East, and Wellington Place, and he was authorised to proceed with these extensions. He also submitted tenders for the supply and erection of additional engines and dynamos required for the central station, which were referred to him to examine and report upon at next meeting.

Brazil.—The S. José Theatre in San Paulo, Brazil, is about to be lighted by electricity.

Brighton.—When the electric current is introduced into the Town Hall for working the passenger lift, it is also to be supplied to the Town Clerk's temporary offices for lighting purposes.

Bromsgrove.—The gas lighting is not satisfactory, and is being inquired into by the Parish Council.

Burton.—The question of electric street lighting so far as concerns High Street, Market Place, Station Street, George Street, Station Bridge, and several other thoroughfares, has been postponed for the present.

Cheltenham.—Alderman Norman reports a gratifying increase in the demand for the electric light. In August the applications amounted to 2,060 8-candle-power lamps, and this month it had risen to 3,376, 3,040 of which were actually connected.

Conisborough.—The Conisborough Glass Works are being fitted up for electric lighting by Mr. J. A. Edmonson, of Leeds.

Coseley.—A report has just been presented to the District Council regarding the lighting of the district. Figures are given of the estimated costs of lighting by oil lamps, incandescent gas, and electric lighting. The following is the statement regarding electric lighting, which we have culled from the *Birmingham Gazette*:—"As to electricity, the only system which could be carried out in a scattered district at a moderate cost was that known as the high tension alternating current system. To light the whole of the district, and to provide for private consumption, would involve an outlay of £12,000 or £14,000, with annual working expenses, including maintenance, interest, &c, amounting to £1,500. He estimated, however, that £1,000 would be received as revenue from private lighting. For public lighting only, the plant would cost £8,700, and the annual working expenses £1,226, equal to a rate of 6d. or 7d. in the pound." The various schemes were referred to a committee for consideration, and to report to the next meeting of the Council.

Dover.—There was a rather lengthy discussion at last week's Council meeting regarding the positions of the lamp standards for the lighting of Snargate Street.

Dundee.—The Gas Committee is recommending the Council to renew, at a cost of £210, the pilot electric wires in connection with the electric light department.

The question of the propriety of introducing incandescent electric lighting into the new hospital is in abeyance for the present. The dining room at the West Poorhouse is, however, to be so lighted.

The electricity rental for the five months, to the end of September, amounted to £907 3s. 4d.—an increase of £189 3s. 4d., when compared with the same period last year.

Eccles.—At last Monday's meeting, the Council had before it a recommendation from the Electric Lighting Committee to accept the tender of the Manchester Edison-Swan Company, Limited, at the sum of £13,792. There was a good deal of discussion regarding the matter, and ultimately an amendment was carried deferring acceptance until the new councillors are elected in November.

Edinburgh.—The Electric Lighting Committee has resolved upon Brockie-Pell arc lamps for the lighting of Charlotte Street, George Street, St. Andrew Square, and the streets leading up to them from Princes Street. The *Scotsman* says that the former contractors could not undertake to supply the present style of lamp at the old price. There is a good deal of lamp globe smashing done at Edinburgh, and mischievous persons are being watched for.

Exeter.—The Common Seal of the City Council has now been affixed to the agreement with the Electric Lighting Company for the purchase of their undertaking. Application is to be made to the Board of Trade for a loan of £11,000 for the purposes of electric lighting. It is anticipated that £3,000 will have to be expended, in addition to the purchase money (£7,500), for new dynamos and other plant.

Godalming.—The Town Council has decided to obtain a provisional order for electrically lighting the district. This decision was arrived at last week, when the special committee appointed to consider the question of public lighting submitted the following report relative to the electric light scheme: "The Highways, Footways and Lighting Committee handed over to your special committee the replies received in consequence of the advertisements in the electrical papers of May 24th, 17 from firms, nine from consulting engineers. Not one of them would undertake the work at their own risk, but simply as contractor for the Corporation. As the result of their deliberations your committee instructed the surveyor to negotiate with Messrs. Fowler & Co., of Leeds, and to canvass a specified area of the borough with a view to finding out how many lights were likely to be adopted." Mr. Girdlestone, chairman of the committee, said it was found to be quite impossible to attempt at first to supply electric light to the whole of the borough, and the committee therefore determined to take a limited area, in which the houses were close together, and to get an estimate for that area. The number of lights counted by the canvass was 2,250, and to this they had to add 250 public lights, making 2,500. Since that he had had the Charterhouse district canvassed, but he was not so successful as he had hoped to be. The headmaster of Charterhouse told him that he was very anxious to have the electric light in the school, but he would give no estimate of the number of lights. The number of lights he got by means of the canvass was 400, and he thought they might certainly double that, if not make it 1,000. This would bring the total number of lamps to 3,500. The only additional cost for lighting the Charterhouse district would be the cost of the cable. The canvasser wrote: "I find a general and strong desire for electric light in the borough, and have no doubt the scheme will be well supported." The recommendation to apply for a provisional order was adopted *nem con.*

Harrogate.—The Council last week resolved to borrow £23,500 for works and plant for the electric light installation, and £1,500 for street lighting. 68 arc lamps will be erected in various parts of the town.

Hove.—The directors of the Hove Electric Lighting Company have decided to charge only 4d. per unit to customers who consume current on the average for two hours a day throughout the year, from and after January 1st, 1896.

Hull.—A Local Government Board inquiry was held here on 3rd inst. regarding the Corporation's application for a loan of £8,000 for electric lighting purposes. It was stated that so far £37,800 had been borrowed for such purposes. It was considered probable that a further application might have to be made shortly.

Some complaints having been made regarding smoke nuisance in connection with the central station, the Electric Lighting Committee are doing their best to abate the nuisance by purchasing apparatus and in other ways.

Horsell.—The result of inquiries recently made regarding electric lighting is, that the Council find it will cost £140 per annum for 24 lamps, according to the estimate of a company. Further inquiries are being made to see what it will cost if the Council supply their own lamps and plant.

Inverness.—The Town Council has resolved to oppose three applications which have been made by companies for provisional orders.

Islington.—The sum of £60,000, which had been sanctioned by the Vestry for the electric lighting undertaking, was found inadequate, and it is proposed to borrow a further sum of £25,000 from the London County Council, at a rate of interest not exceeding 2¾ per cent. per annum, repayable within a period of not less than 42 years. Mr. J. Lambert explained at the last meeting of the Vestry that the reason the committee had exceeded the original amount was because they had obtained the best machinery and plant. The demands made upon the committee for the supply of lamps was very great, and it was extremely likely that they would have to apply for a still further loan for more machinery. The debate was ultimately adjourned till next meeting.

Lambeth.—A member tried at the last Vestry meeting to reintroduce the question of electric lighting by moving that a special committee be appointed to consider carefully all information obtainable on the question and report. After discussing the matter, a motion to adjourn the Vestry was carried.

Liverpool.—The City County Council, at their last meeting, expressed the greatest dissatisfaction with the gas lighting service, and thinking they could do it better and cheaper themselves, decided to apply for a provisional order to empower them to start a competitive gas supply.

Limerick.—A communication received from the Board of Works requesting further particulars as to the steps to be taken by the Council in the matter of providing buildings, &c., for the electric lighting scheme, is at present under consideration.

Mevagissey.—At the last Parish Council meeting, Mr. Kemble presented the report of the Electric Light Committee, which showed that the scheme for forming a company was meeting with scant success. Veale & Co., of St. Austell, had promised to take £300 worth of shares, and £250 had been promised by people of the town towards the £1,300 required to float the company. The Council decided to give the committee a month more to continue their labours.

Mile End (London).—The Vestry has appointed a committee to consider the advisability of lighting the district by electricity.

Monmouth.—At the last meeting of the Town Council, in reply to a letter asking further information respecting a combined scheme for sewerage and electric lighting, the engineers (Messrs. Bramwell & Harris) showed that the drainage alone would cost £12,000, and would require a rate of 1s. in the £, while if the combined scheme were carried out, at a cost of £20,000, the saving of the cost of public lighting, added to the earnings of 1,900 8-candle incandescent lamps, at 6s. 8d. per lamp, for which the Corporation have already an order, would reduce the rate to one of 6d. in the £.

Newport.—The Mayor has been asked to open the Corporation Electrical Works on Monday next, and at the same time to turn on the supply for the arc lamps which have been placed in the principal streets.

Newquay.—We have already mentioned that the Baths and Steam Laundry Company has decided to use electricity for lighting, and heating the irons of the mechanical ironers, &c. We now learn that the installation has been carried out by J. S. Cunnington and Co., of 5, John Street, Adelphi, W.C.

Newcastle.—It is proposed to engage Mr. Selby Bigge, electrician, and Mr. John Thompson, engineer, to report as to cost, &c., of lighting the Newcastle Workhouse with electricity for the guardians.

Oswestry.—With regard to the electric lighting of the Cross Market, it was stated at the last Council meeting that the Oswestry Electric Lighting Company were prepared to supply six 500-candle-power lamps at £40 per annum, the cost of the gas lighting at present being £42 3s. 6d. The tender of Mr. Reakes, of Shrewsbury, for the installation of the lighting at £52, was accepted.

Runcorn.—The lighting question is under consideration with special reference to the cost of electric lighting. A committee of the District Council has the matter in hand.

South Africa.—We cull the following paragraphs from the *British and South African Export Gazette*:—

Messrs. Delfos Bros., Pretoria, have secured the contract for supplying Bloemfontein with the electric light.

The Cape Government Railways are about to discard the accumulator system in the electric lighting of their trains. In future the current will be provided from a dynamo worked direct from an oil engine. Each train will, of course, require to be equipped with a separate plant.

It is proposed to add electric lighting plant to the machinery on the Luipaa d's Vlei Estate mine.

New accumulator electrical plant has been added to the existing plant at Heath's Hotel, Johannesburg.

The Johannesburg Sanitary Board have accepted the tender of Mr. J. Hubert Davies, M.I.C.E., Johannesburg, for electrical plant.

A dynamo is to be added to the plant on the New Midas property for lighting and pumping purposes.

Sale.—Notice had been given to the Council by the Altrincham Electric Supply Company, stating that they intended to apply for a provisional order for lighting the district. It was decided that a special meeting of the Council should be held on November 5th to consider the matter.

Spain.—The public streets of Lorca, an important town in the province of Murcia, are shortly to be lighted by electricity, work being well in hand on the establishment of a central station intended for private as well as public lighting purposes.

Swansea.—The Borough Council, on 2nd inst., resolved, by 14 votes to 13, to proceed with the proposed electric lighting and dust destructor scheme, upon which a committee had reported. Motions in favour of delay were accordingly lost.

The *Western Mail* says that a petition is to be made to the Mayor, asking him to convene a public meeting before the electric lighting scheme is sanctioned.

Tunbridge Wells.—The Corporation electric lighting installation was inaugurated on Wednesday by Sir David and Lady Salomons. An exhibition of electrical appliances was opened on Monday in connection with the event, which will be continued during the week.

Wells.—At the last Council meeting, it was reported that Dr. Hopkinson had visited the city, and made his report on electric lighting. The report was a very favourable one. The Town Clerk was instructed to take the necessary steps for obtaining a provisional order.

Wigan.—The Town Council, on 2nd inst., received the report of the sub-committee appointed to deal with the question of an installation of electric light. The mover of the adoption of the report asked the Council to decide once for all whether they would proceed with a scheme of electric lighting for the borough. Alderman Smith strongly advised the sub-committee to call in a specialist before proceeding any further. Mr. Trickett asked what would be the probable cost of carrying out the scheme. Mr. Holmes replied that it would be about £16,000. Alderman Smith moved, and Mr. Laycock seconded, an amendment to the effect that the scheme be not proceeded with until the advice of an expert was obtained. Subsequently the Council adopted the report of the committee.

Worcester.—The Council are applying to the Local Government Board to approve of their borrowing £1,300 for wiring the Guildhall and Public Hall for electric lighting, to be repayable in 25 years.

Weybridge.—The District Council discussed the lighting question last week. There seems every likelihood of a contract with the gas company being entered into.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Brighton and Rottingdean Seashore Electric Tramroad.—At a meeting of the Brighton Town Council last week, the Works Committee reported the receipt of an application from Mr. St. George Moore, engineer to the above company, for permission to reduce the height at which the rails of the tramroad are to pass the side of the proposed new groyne at Blackrock from 3 feet to 1 foot 6 inches or 2 feet. The surveyor, however, reported that if this were done the part of the groyne lying south of the line of the tramway, 93 feet in length, would be useless for the purposes for which the groyne was originally designed, and the Committee accordingly resolved with regret that they could not accede to the application. The Committee also reported that a letter had been received from Mr. Volk requesting permission to erect 13 steel poles on the foreshore, between Paston Place and the eastern boundary of the borough, for the purpose of carrying electric wires. The Committee decided to inform Mr. Volk that the Council cannot sanction the erection of overhead electric wires, but will grant permission for the conveyance of electricity required for the railway by underground wires, subject to the details of the work being approved by the borough engineer. In the course of the discussion which followed, it was urged that the erection of the poles would do no harm to anyone, and eventually the matter was referred back to the Committee for further consideration.

Electric Traction in Italy.—A new line of electric tramways has lately been put in operation between Milan and Musocco, a distance of about 5 kilometres. The line is on the Thomson-Houston overhead conductor system. The power station is situated at Musocco and comprises two Galloway boilers, two 150-H.P. engines constructed by Messrs. F. Tosi & Co., of Leguano, and two 100-kilowatt Thomson-Houston dynamos. A company has just been formed at Lugano, with a capital of £8,000, to be known as the Tramvie Ellettricte à Lugano to construct and operate an electric tramway between Lugano and Cassarate, with a branch to Moulin-Neuf. The Allgemeine Electricitäts Gesellschaft, of Berlin, is making good progress with the establishment of the system of electric tramways in the town of Genoa. Three lines have already been completed and put in operation, viz., Genoa-Briagno Valley, Genoa-Campo Santo, and Genoa-del Regardo. The latter is a cable tramway operated by electricity.

Electric Tramway at Buenos Ayres.—According to a Renter's despatch, an underground electric tramway is about to be constructed in Buenos Ayres. The work will be begun shortly.

Electric Traction in France.—It is proposed to construct an electric tramway between La Tour d'Argues and Pertuis (Vaucluse). The Bordeaux Vigean Electric Tramway is to be extended to Blanquefort. It is also proposed to establish an electric tramway at Arcachon connecting the two parts of the town.

Electric Traction in Germany.—A contract has been given out by the Municipal authorities of Eisenach for the construction of an electric tramway between that town and Annathal. The electric tramway between Herne and Boctum is fast approaching completion. Messrs. Siemens & Halske, of Berlin, who are constructing the line under a concession have just had this extended to a period of 33 years. Work on the construction of the tramway between Wattenscheia and Boctum is also well in hand.

Electrical Appliances for Quarries.—The Perth County Road Board are petitioning Parliament in favour of power being granted to road authorities to use steam engines or electrical or other mechanical appliances for boring and blasting rock or for breaking rock or road metal.

Electric Transmission Plant.—On Saturday afternoon a large company of mining engineers and others visited the works of Messrs. Ernest Scott & Mountain, Limited, electrical and general engineers, Close, Newcastle, the chief object being an inspection of some very powerful electric transmission plant, constructed by the firm for the St. John Del Rey Mining Company, and to be used in the company's Morro Velho mines in Brazil.

Halifax Tramways.—Communications from Messrs. Easton, Anderson & Goolden, Limited, offering plans for an overhead system of tramways on the electric principle, are to be considered by the new council to be elected next month.

Port Elizabeth and Electric Tramways.—An exchange says that a large scheme of electric tramway construction is shortly to be undertaken at Port Elizabeth by Mr. Butters, the energetic promoter of the same system of street traction in Capetown. He is now in England.

Proposed Electric Tramways at Dover.—The Dover Corporation on Wednesday decided to apply for Parliamentary powers to introduce a system of electric tramways to cost about £50,000.

South Africa.—The *British and South African Export Gazette* says:—We believe that the Jubilee Company will be giving out orders for electrical plant before very long. They have placed an order for the construction of a water race from the Blyde river for generating electric power. It is proposed to supply electrical power to the mines on the Murchison Range, and to pump water from the Silati river, from a central station to be erected on the Oliphants river. The pumping gear on the Champ D'Or French property is to be worked by electricity. The new motors for driving the battery on the United Ivy mine have been fitted up. The Heidelberg Roodepoort Company has had prepared specifications for electrical plant, but we understand that the order has not yet been placed. Electrical machinery for hoisting, pumping, and other mining work on the Bonsor property has been ordered in England.

TELEGRAPH AND TELEPHONE NOTES.

A Cable up the Amazon.—The *Times* of Wednesday says Mr. Alexander Siemens, with a representative of Messrs. Clark, Forde & Taylor, consulting engineers to the Amazon Telegraph Company, Limited, is now engaged in surveying the route for the new cable about to be laid up the Amazon from Pará to Manaos under exclusive concessions from the Government of the Brazilian Republic. The entire length is 1,365 nautical miles, and there will be in all 16 stations on the line. The *Faraday* will probably leave England next month with the cable, more than half of which is already manufactured. This long sub-fluvial line will for the first time bring these regions, so increasingly productive of India-rubber, coffee and sugar, into direct telegraphic communication with Europe. All past attempts on the part of the Brazilian Government to establish aerial lines through these districts have failed, owing to the rapidity and density of the forest growths. Mr. Reidy, representative of the Amazon Telegraph Company, joined the expedition at Pará. The great importance of the Amazon as a trade route may be gathered from the fact that the *Faraday*, a steamer of 5,000 tons burden, will proceed all the way up to Manaos, a distance of 1,100 miles from the mouth of the river.

The Island of Trinidad.—A despatch from Rio de Janeiro on 8th inst., says that the delay in settling the question of the Island of Trinidad is causing a certain uneasiness, and the attitude of the Government in the matter is being censured by the Press.

Telephonic Communication between Germany and Austria.—It has been decided by the Chamber of Commerce at Eger, Austria, to approach the Government with reference to the establishment of telephonic communication between that town and Plauen and Hof in Germany.

Telephone between Berlin and Copenhagen.—On the 8th inst., telephonic communication between Berlin and Copenhagen *via* Hamburg was opened. The tariff for an ordinary conversation of three minutes duration is three marks.

Telephonic Communication in Germany.—Telephonic communication is about to be established between Munich and Hanau. A new interurban line connecting Ettlingen, Carlsruhe, Mannheim, and Durlach, in Baden, on the one hand, with Mulhausen, Strassburg and Colmar, in Alsace, on the other, has just been completed and put in operation.

Telegraphic Communication in Switzerland.—The Swiss Federal Council is applying for a credit of 50,000 francs for the erection of military telegraph lines in the Gothard district.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belgium.—October 16th. Tenders are invited for the supply of two lots of telegraph cables and copper wire for the telegraph service. Tenders to the Direction Generale des Chemins de Fer, Postes et des Telegraphes, La Bourse, Brussels.

Bolton.—October 15th. Tenders are wanted for the installation of electric lighting at the Poor Law Offices, Mawdsley Street, for the Bolton Union. Particulars from the Union Clerk, 26, Mawdsley Street, Bolton.

Brussels.—October 16th. We understand that tenders are wanted for the supply of copper cables and wire (bare and covered) required for the telegraph service—first lot, 1,300 to 2,000 metres of house wire with two conductors; 1,200 to 1,300 metres of the same; 300 to 400 metres of twin flexible; 700 to 900 metres of the same; 1,500 to 1,800 metres of the same—caution money, 1,700 francs; second lot, 675 to 900 kilos of soft annealed copper wire of 12 mm. diameter; 200 to 300 kilos of 16 mm. diameter; 300 to 450 kilos of 20 mm. diameter; 155,000 to 200,000 metres of copper wire, G. P. covered with a layer of white cotton and a braiding of dark cotton; 87,000 to 110,000 metres of the same with a layer of tarred tape; 30,000 to 55,000 metres of the same with an incombustible covering; 2,500 to 3,500 metres of twin flexible—caution money, 3,500 francs. Tenders will be received at the Bourse, Brussels. Particulars from Administration des Chemins de Fer et des Telegraphes, Brussels.

Edinburgh.—October 12th. Tenders are invited for the wiring of the Waverley Market, for the Lord Provost, Magistrates, and Council. Particulars from the resident electrical engineer's office, 5, Dewar Place, Edinburgh.

Edinburgh.—October 22nd. The Corporation invites tenders for carbons.

High Wycombe.—October 14th. The Chepping Wycombe Urban Sanitary authority invite tenders for working the electric lighting provisional order obtained by them within the borough, for a term of years and upon approved conditions. Tenders to be delivered to the Town Clerk, High Wycombe, from whom further details may be obtained.

Leicester.—October 12th. Tenders are wanted for the erection, at their New Swithland reservoir pumping station, of four Lancashire boilers, each 27 feet 6 inches long and 7 feet diameter, for the Corporation of Leicester. Particulars from Mr. J. B. Everard, M.I.C.E., 6, Millstone Lane, Leicester.

Madrid.—November 15th. The Director of Public Works is inviting tenders for the concessions of the construction and working of a tramway from Madrid to Colmevar Viejo, with branches to Chamartin and Rosa. Security 12,505 pesetas. Particulars at the Direccion General de Obras Publicas (Ministerio de Fomento), Madrid.

Newport (Mon.).—October 11th. To-day tenders have to be in for wiring and for supplying and fixing electrical fittings at the provision market and public baths, Newport, for the Corporation.

Rangoon.—November 4th. The Municipal Committee is inviting tenders for electric lighting. Particulars to be obtained from Messrs. Ogilvy, Gillanders & Co., 67, Cornhill, E.C.

Roumania.—The Municipal Authorities of Bucharest, Roumania, are at present inviting tenders for the supply of a number of electric lamps and arc light carbons required in connection with the public street electric lighting.

Southampton.—October 21st. Tenders are invited for supplying and fixing a gas-engine and mixing machinery for the treatment of sewage at the Platform Works, for the Corporation, in accordance with plan, specification, particulars and conditions to be seen on application to Mr. W. B. G. Bennett, borough surveyor.

South Molton (North Devon).—Tenders are invited for wiring the factory buildings for the electric light and ironing, including all the electric generating plant, for the Southmolton Shirt and Collar Manufacturing Company, Limited. The company find the power. Particulars from the Secretary.

Spain.—October 15th. Tenders are being invited by the Municipal Authorities of Soria, a small agricultural town in Soria province, for the concession for the electric lighting of the public streets during a period of 20 years. Tenders to be addressed to the Ayuntamiento de Soria, Spain.

Vienna.—November 14th. The Municipality of Vienna asks for tenders and plans for the construction and working of electric railways in and around the city. The notice may be seen at the Commercial Department of the Foreign Office.

NOTES.

Test of Electric Cars on the Nantasket System.—An American exchange states that electricity as a motive power and its practical use in handling freight on railroads were tested recently on the Nantasket beach electric system of the New York, New Haven and Hartford Railway, to which we referred in our issue of July 19th. The experiments were made with motor cars and flat cars heavily freighted with Quincy granite, and were witnessed by a large number of the railroad officials, who regarded the tests as satisfactory and indicative of a revolution in railroad traffic within a few years. Two-motor car, No. 2,503, was first tested with a load of nine cars with a combined weight of 302 tons. As this load was too heavy the cars were dropped off, one at a time, until only five remained, which were drawn fairly well. Then the 4-motor car, No. 2,500, was ballasted with 5,000 lbs. of iron and attached to seven loaded cars weighing 234 tons. It drew the load easily and there seemed to be no great effort when the load was increased to eight cars and 273 tons, and afterwards to nine cars and 303 tons. Then the motor car ballast was increased to 5 tons, and the car easily pulled ten car loads of freight weighing 335 tons. Twelve car loads, weighing 400 tons were also handled without difficulty, but with 14 cars, weighing 470 tons, the train moved slowly, as it was exerting a power equal to that of a 42-ton locomotive. The two motor cars were then coupled together and attached to various loads up to 30 cars, weighing 954 tons, which were successfully hauled. While making this test something gave out on the 4-motor car, and the less powerful car handled the entire load. Then the 2-motor car was attached to six cars weighing 215 tons, and carried them to the Nantasket yard. Tests were also made with the open motor cars, one of which, with a single motor, easily hauled a car load weighing 39 tons to the power station and return, subsequently hauling two cars of 40 tons each. At the conclusion of the freight power tests the gentlemen present were treated to an exciting exhibition of the speed of electric cars. An open car was run down to Pemberton at a speed of 58 miles an hour. On the return the car was sent spinning along with a velocity of 72 miles an hour. President Clark, of the New Haven Railroad, expressed himself as much pleased with the results of the tests. He said that electric cars at frequent intervals can haul freight cheaper and better than it can be done with steam. He also intimated that the railroad of which he is president will soon adopt a system of suburban electric traffic, and he thought the people of the South Shore would be given an opportunity, within two years, of riding to Boston on electric cars.

Death from Electric Shock.—On September 17th a lineman was killed by falling on a feed cable of the Southern Boulevard branch of the Union Trolley Road in New York. He was tightening one of the cross wires which support the trolley wires proper, when he threw up his hands and grasped at random for support. His right hand closed on the feed wire. A current of 550 volts was passing through the circuit at the time. The shock threw him forward, and he fell with his abdomen across the cable. His clothing and body were burned, and he died in a few minutes. The New York *Electrical Review*, commenting on the sad occurrence, says: "It is extremely unusual for a railway current of 550 volts to have a fatal effect. The man must have been allowed to be in contact with the live wire for considerable time. In these days there is no excuse for not trying the means of resuscitation which are familiar to every sensible electrical worker."

The Falls of Foyers.—The following correspondence, which we have taken from the *Times*, has passed between the Duke of Westminster and the British Aluminium Company, Limited, 9, Victoria Street, Westminster, respecting the Falls of Foyers:—

9, Victoria Street, Westminster, S.W.,
September 19th.

To his Grace the Duke of Westminster, K.G.,
Grosvenor House, W.

My Lord Duke,—I am instructed by the directors of this company to write in reference to the letter, dated July 31st last, signed by your grace, and published in the *Times* and other newspapers, which comments upon their proposed works in Scotland.

The company, considering that they alone had the right to deal with their own property, have hitherto refrained from entering into any controversy in the public Press concerning the works they propose to erect at Foyers; but the great importance that has been given to your grace's letter, by its frequent republication and comments in the Press, makes it necessary, in the opinion of those who advise the company, that the incorrect statements made therein, founded, no doubt, on improper information given to your grace, should now be publicly corrected. The directors feel sure that it will only be necessary to show to your grace wherein these statements are wrong, to have them corrected in the same public manner as they have been made, and that they are not mistaken in supposing your grace will, after reading this letter, cause these corrections to be made.

Your grace states that, in connection with the aluminium works which are about to be started at Foyers, great spoil heaps will be created. As a matter of fact, the process to be carried out at Foyers consists only of the electrolytic decomposition of the oxide of aluminium, and consequently there will be no solid or liquid residuum, and no heaps formed which will spoil the beauty of the place. The oxide of aluminium is obtained from the company's mines in Ulster in the form of bauxite, which is afterwards treated at the company's works at Larne, so as to free it from its impurities.

Secondly, it is stated in the same letter that the factory there will emit hydrofluoric acid gas, which will be most destructive to the vegetation in the neighbourhood. If this were the case, the only party concerned would be the company, as proprietors of the land for several miles round the site of the factory. In reality, however, no such destructive effect will occur, as your grace's informants could have easily found out by procuring a report as to the state of the vegetation in the neighbourhood of the Continental factories at Schaffhausen and Froges, or by reading the official report on this matter published by the Swiss Government authorities.

There remains an allegation in your grace's letter to be answered, viz., that the agent of this company has stated that "the Falls will not be injured, only there will be no water in them." This statement is untrue, and was not made by any person in the employ of the company.

The company has never contemplated taking all the water passing over the Falls, or interfering with their natural structure, and such water as the company does not use will pass over the Falls as at present, but should the company's proposals for the storage of the water during flood times not be allowed, the company may reluctantly be compelled to utilise in times of scarcity the whole of the flow.

The works carried out at Foyers will be very beneficial to the whole district, and consequently the company have received the cordial support of the local authorities and inhabitants. Those who are well acquainted with the neighbourhood recognise that the submergence of the boggy land between Lochs Garth and Farraline, and the creation of one grand loch, will be a distinct improvement to the scenery.

Your grace will therefore see that the attempt to influence the decision of the county council is calculated, if successful, to defeat the object your grace has in view, viz., the securing the amenities of the place to those visitors who desire to view the beauties of the Highlands.

The directors have fully considered the scheme for the production of this metal, and have adopted the only method open to them to secure to this country the benefit resulting from this important industry.

The directors feel convinced that your grace will, without delay, correct publicly the misleading statements contained in the above-mentioned letter, which are undoubtedly due to misrepresentations made to your grace by persons not possessed of adequate information.

I beg to remain, my Lord Duke, your obedient servant,
For the British Aluminium Company, Limited,
Charles F. Jones, *Secretary*.

September 30th, 1895.

Duke of Westminster, Eaton Hall, Chester.

We wrote your grace on 19th inst., under registered cover, asking for public contradiction of misleading statements made in your letter concerning our business. So far we have received no reply, and, besides, to-day a letter is published by someone connected with your grace in this matter making baseless insinuations against honourable people who have acted straightforwardly and for the good of their district. Unless a thorough retractation is published before next Thursday, October 3rd, we shall feel compelled to send the whole of the correspondence to the public press.

British Aluminium Company,
9, Victoria Street, Westminster.

Eaton, Chester, *October 3rd*, 1895

Dear Sir,—I am directed by the Duke of Westminster to acknowledge the receipt of your letter of September 19th with regard to the works that it is proposed to erect at Foyers.

His grace is afraid that he cannot correct the alleged mis-statements in his letter of July 31st, and would suggest that the directors of the British Aluminium Company should, if they see fit, publish your letter of September 17th as a reply to his grace.

I regret that there should have been a delay in replying to your letter, which was sent to me by his grace at a time when I was travelling in Scotland, and which I inadvertently mislaid.

With many apologies for the consequent apparent want of courtesy,

I remain, yours faithfully,
Arthur Lawley.

The Secretary, British Aluminium Company.

The Institution of Junior Engineers.—The annual general meeting of this Institution was held last Friday, October 4th, at the Westminster Palace Hotel, the retiring chairman, Mr. H. J. Young presiding. The principal business was the presentation of the Council's report on the proceedings of the past year, and the election of officers for the ensuing session. The report showed that steady advancement had been maintained. The membership roll had increased by 45, the total at the present time being 418. The Institution premium for the best paper read by members during the session had been awarded to that on "The Warming of Buildings by Hot Water," of which Mr. E. King and Mr. Kenneth Gray were joint authors. The library had been well used, but its utility could be greatly increased by the provision of a reading room, which, together with an office, the Council were hoping they would soon be able to secure. An office fund had been opened for the purpose. The total receipts on general account had been £487 1s. 2d., and expenditure £474 3s. The result of the election was:—Chairman, H. J. Young; Vice-chairman, H. B. Vorley.

On Thursday, October 17th, at 6.30 p.m., the members of this Institution will visit Messrs. Caird & Rayner's Works, 777, Commercial Road, Limehouse, E.

Newspaper "Technics."—In the course of an article, apparently editorial, on the death of M. Pasteur, in *Truth* for October 3rd, the following passage occurs:—

> Pasteur heard with indignation of a novel entertainment given in honour of the Medical Congress held in London in 1892. The person who gave it wishes to rank as a great scientist. He had collected, by the aid of *microphones* (the italics are our own), the sighs and groans of sick wards and of surgical amphitheatres, and the last words of patients dying of consumption and other lung and throat diseases.

The writer meant "phonographs."

In a new story by Allen Upward in the *Weekly Dispatch*, we have, as a prologue, "The Loading of the Pistol." Nearly three-quarters of a column is devoted to this simple operation, and we read:—

> The giant, who had watched this operation with the closest attention, now took the pistol once more, and completed the work of preparation by fitting on the percussion cap, over which he allowed the *trigger* (the italics are our own) to close down.

Mr. Upward should have written the "hammer," but probably he had no more practical acquaintance with fire arms than the writer in *Truth* has with scientific apparatus.

The Hermite System in the East.—The following paragraph is culled from *Indian Engineering*:—"Both the Singapore Municipality and the Hongkong Sanitary Board have refused to adopt the Hermite system of treating sewage with electrolysed sea-water. The Secretary to the Sanitary Board of Hongkong was of opinion that the cost in connection with the system would in a very short time greatly exceed the cost of putting the drains in proper order."

Institution of Civil Engineers.—On Thursday, May 7th, 1896, the James Forrest lecture on the applications of science to engineering is to be given by Dr. Alexander B. W. Kennedy, F.R.S.

Electric Lighting of Tramcars.—The North Metropolitan Tramways Company are apparently awakening to the fact that their cars, or the majority of them, are lighted in such a manner as to irritate those who, after dark, are compelled by force of circumstances to use their conveyances, and who desire to dispel the monotony of such a journey by reading the evening paper. The cars, on some sections of the company's lines, are at present lighted by an oil lamp at either end, which sheds a light upon the paper of the two passengers who have secured the right seats, and causes annoyance to those who are not so favourably circumstanced. It seems that the only remedy for this state of affairs is to light the cars by well arranged electric lamps, which shall not be required to play the double part of illuminating cars inside, as well as acting as outside signal lamps. The company is well advised in adopting, experimentally, electric lamps for lighting the cars on the Aldgate and Stratford route.

The Tesla Patents in France.—It was recently stated in *L'Industrie Electrique* that Messrs. Schneider et Cie, of Creusot, who, in 1893, purchased exclusive rights to the Tesla rotary field patents for France, have entered suit against the French manufacturers of Brown and of Oerlikon motors in France, and against the Lyons representative of the Swiss firm of Alioath, which makes rotary field motors.

Lecture.—Prof. H. Stroud, M.A., D.Sc., delivered the opening lecture in the technical electricity course at the Durham College of Science, Newcastle, on the 30th ult., addressing a large audience on "The Electric Current: its Production and Uses."

Schemes Wanted.—The Battersea Vestry want schemes, reports, designs and estimates for lighting the parish by electricity. Three premiums are offered for the best schemes sent in. Particulars will be found in our "Official Notices."

Appointment.—Mr. A. S. Barnard of Lancaster has been appointed to the post of electrical engineer to the Hull Corporation.

NEW COMPANY REGISTERED.

Headland's Patent Electric Storage Battery Company, Limited (45,524).—This company was registered on October 4th with a capital of £15,000 in £1 shares, to acquire and carry on the business of electricians and electrical apparatus manufacturers carried on by H. and E. Headland at High Street, Leyton, Essex, and to adopt a certain agreement. The subscribers (with one share each) are:—E. E. Cronk, 12, Pall Mall, S.W., surveyor; J. H. Oxley, 95, Upper Thames Street, E.C., merchant; F. Cronk, 12, Pall Mall, S.W., auctioneer; P. J. McManus, 44, Gutter Lane, E.C., merchant; T. H. Byron, 53, Beauchamp Road, Clapham, clerk; H. W. Headland, High Road, Leyton, electrician; A. F. White, 27, Park Road, Forest Hill, clerk. H. W. Headland is to act as works' manager at a salary of £4 per week. Registered office, 12, Pall Mall, S.W.

CITY NOTES.

Willans & Robinson, Limited.

The ordinary general meeting was held on Tuesday at the Cannon Street Hotel, Mr. Mark Robinson presiding.

The Chairman, in moving the adoption of the report, congratulated them on having had a prosperous half-year. They had had something of a windfall, but without this the results would have been better than those of the previous half-year. That they had done better than in the last half-year was important for two reasons. In the first place, they had to bear the burden of much idle capital intended for the Rugby extension, which obliged them to earn more dividend without helping them to earn it. So far, they had met this obligation, and a little more, even without the windfall, but it must not be forgotten that for the next half-year or two, until Rugby was fairly at work, this was an evil which must tend to increase. In the second place, the first half of the year was usually their worst half—a fact which should give them anticipatory comfort for the present half-year. As regarded the dividend, they hoped that in continuing it at 7 per cent. they would meet with the shareholders' approval. If they could keep up this rate of interest in a time of transition, while continuing to build up a large reserve, they would feel that they had fulfilled their promises in the present, and had given the shareholders a good hope of surpassing them in the future. He was sorry to say that they would not be able to achieve their original aim of having the new works in operation by Christmas. The new foundry might give them help at an earlier date, but the machine shop could not aid them much until the spring was well advanced. Rugby must, in the future, be the headquarters of the company, and Thames Ditton the adjunct. The debenture debt had been paid off. The extension of their foreign license business was a good augury in every way. He regretted to say that the question of a Stock Exchange quotation for their shares was still unsettled, although he believed there was no doubt about its being granted.

Mr. Erskine (a shareholder) seconded the motion, which was carried unanimously after a short discussion, and the dividends recommended on the preference and ordinary shares were afterwards approved.

The Westinghouse Electric Company, Limited.

The directors' report, to be presented at the general meeting on 15th inst., presents the balance-sheet for the year ending September 30th, 1894, and says that the "Agreement between the English and American companies, referred to in the last report and approved by the shareholders at the general meeting held in September last, has been carried out. After providing for all expenses of management, directors' fees, depreciation of stock and office furniture, patent taxes and other expenses connected with the maintenance of the various English and foreign patents owned by the company, there is a nett profit for the year amounting to £7,725 1s. 11d., which, added to the sum brought forward from the previous accounts, makes a total of £20,739 18s. 7d. to the credit of profit and loss, which the directors propose to carry forward. Owing to the continued increase in the sales of the Shallenberger meter, the directors have found it necessary to provide more extensive laboratory accommodation, for the purpose of ensuring careful tests and adjustments of the meters being made before despatching them to purchasers. This accommodation they were enabled to secure at their Chelsea warehouse, and they are glad to be able to report that they have now a laboratory complete with the very best instruments and apparatus necessary for the purposes above mentioned. The sales of meters during 1894 have been satisfactory, and orders for transformers and other apparatus were also in excess of those of previous years. The directors have, as before, waived their right to one-half of the fees to which they are entitled under the articles of association. Mr. Oscar H. Baldwin, who was previously associated with the English Company, has returned to London, and, on the recommendation of Mr. Westinghouse, has been appointed manager of the company with a seat on the board. While the present report deals only with the period covered by the accounts submitted herewith, namely, to September 30th, 1894, the directors think the shareholders will be glad to know that they have purchased a controlling interest in the European patents, covering a new system of electric traction in which the conductors are placed underground, and which they believe will prove to be a very valuable asset. Further, they have agreed with the American Company on a new and more favourable basis of prices for all apparatus manufactured by that company, which should prove advantageous and lead to increased business. Under the articles of association Mr. Albert Kapteyn retires from the board, and, being eligible, offers himself for re-election. The auditors, Messrs. Price, Waterhouse & Co., also retire, and offer themselves for re-election."

From the auditors' foot note, we understand that they passed the accounts on February 26th last!

Anglo-American Telegraph Company, Limited.—The directors have resolved, after placing £6,000 to the credit of the renewal fund, to declare an interim dividend for the quarter ending September 30th, 1895, of 10s. per cent. on the ordinary stock and 20s. per cent. on the preferred stock, less income tax, payable on November 1st to the stockholders registered on the books of the company on September 30th, 1895.

Stock Exchange Notices.—The Stock Exchange Committee have ordered the undermentioned securities to be quoted in the Official List:—Central London Railway Company—9,104 shares of £10 each, fully paid; 207,649 shares of £10 each, £2 paid. Electric Construction Company, Limited—Further issue of 3,498 7 per cent. cumulative preference shares, Nos. 12,846 to 16,343. W. T. Henley's Telegraph Works Company, Limited—Further issue of 3,163 ordinary shares, Nos. 1 to 601, 1,092 to 1,181, and 7,529 to 10,000.

Salt Lake and Ogden Gas and Electric Light Company, Limited.—A prospectus has been issued by this company in which they invite applications until 4 p.m. to-day, 11th inst., for an issue of 100,000 5 per cent. cumulative preference shares of £1 each, convertible when fully paid into preference stock.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending October 6th, 1895, amounted to £987; week ending October 7th, 1894, £892; decrease, £5; total receipts for half-year, 1895, £11,858; corresponding period, 1894, £12,011; decrease, £153.

The Great Northern Telegraph Company. The traffic receipts in September, 1895, were £28,400; January 1st to September 30th, 1895, £231,300; corresponding months, 1894, £227,400; corresponding months, 1893, £203,600.

The Liverpool Overhead Railway Company. The receipts of this railway for the week ending October 6th, 1895, amounted to £1,088; corresponding week last year, £908; increase, £180.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending October 4th, 1895, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company Limited, were £3,071.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation Oct. 2nd.	Closing Quotation, Oct. 9th.	Business done during week ended Oct. 9th, 1895. Highest.	Lowest.
173,400*l*	African Direct Teleg., Ltd., 4 % Deb.	100	...	4 %	4 %	102 —105	102 —105	...	...
1,912,880*l*	Anglo-American Teleg., Ltd.	Stock	£2 15s.	£2 11s.	£2 2s.	48 — 50	47 — 49	...	...
2,993,560*l*	Do. do. 6 % Pref.	Stock	£5 10s.	£5 2s.	£4 4s.	89 — 90	87½ — 88½	89⅜	87⅞
2,993,560*l*	Do. do. Defd.	Stock	...	...	...	8½ — 9	7⅞ — 8⅛	7⅞	7⅞
130,000	Brazilian Submarine Teleg., Ltd.	10	6½% §	6½% §	...	14 — 14½	14 — 14½	14½	14
75,000*l*	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	...	111 —115	111 —115	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	10%‖ §	... §	2½%	3½ — 4	3½ — 4	3⅝	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	no quotation	164 —168 xd	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	2 % §	2 % §	1½%	1/16 — 3/16	1/16 — 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	13 — 14	13 — 14	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	20 — 21	20½ — 21½	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	4 — 5 xd	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	9½ — 10 xd	9⅝ — 10½	...	...
30,000*l*	Do. do. 4½ % Debs Nos. 1 to 6,000 ...	50	...	...	4½%	103 —106 %	104 —107	...	...
60,710	Direct United States Cable, Ltd.	20	3½% §	2⅝% §	2 %	9 — 9½	8⅞ — 9¼	9 1/16	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6⅜% §	6⅜% §	6¼%	17⅛ — 17⅜	17¼ — 17½	17⅜	17
70,000	Do. 6 % Cum. Pref.	10	6 % §	6 % §	6 %	18 — 18½	18 — 18½	18½	18⅛
102,100*l*	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	5 %	107 —110	107 —110	...	...
1,297,837*l*	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4 %	129 —132	129 —132	131½	130½
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	18 — 18½	18 — 18½	18⅜	18⅛
54,100*l*	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5 %	103 —107	103 —107	...	...
194,300*l*	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5 %	104 —107	104 —107	...	...
320,000*l*	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	128 —131	128 —131	129	...
80,600*l*	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5 %	103 —107	103 —107	...	...
107,600*l*	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5 %	104 —107	104 —107	...	...
300,000*l*	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4 %	108 —111	108 —111	...	...
200,000*l*	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	114 —117%	114 —117 %	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅞% §	4⅝% §	4¼%	10⅛ — 10⅜	10⅛ — 10⅜	10⅜	10¼
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	6 %	17 — 17½	17 — 17½	17 1/16	17 1/16
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅝% §	8⅝%	8⅝%	21¾ — 22¼	21¾ — 22¼	21 13/16	
180,000*l*	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	103 —106	103 —106	105½	104
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	50 — 53	50 — 53	52½	51⅛
100,000*l*	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6 %	105 —109	106 —110	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	...	...	...	2 — 2½	2 — 2½	2⅛	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 % §	5 % §	5 %	6⅛ — 6⅜	6⅛ — 6⅜	6 5/16	6⅛
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 — 18	16 — 18	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 16	15 — 16	15⅜	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6⅛ — 6⅛	6⅛ — 6⅛	6⅜	...
1,100,000*l*	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	106 —108	106 —108	107½	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	...	4¼%	1/16 — 1/8	1/16 — 1/8	...	...
100,000*l*	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	108 —111	09 —112	...	...
11,839	Reuter's Ltd.	8	5 %	0 %	*nil*	5 — 6	5 — 6	5⅜	...
3,381	Submarine Cables Trust	Cert.	...	...	...	128 —133	128 —133	130	...
58,000	United River Plate Teleph., Ltd.	5	...	...	...	2¾ — 3¼	2¾ — 3¼	...	...
146,733*l*	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	93 — 98	93 — 98	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	..	...	*nil*	5½ — 6½	5½ — 6½	...	...
238,300*l*	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	104 —107	104 —107	...	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	..	1½ — 2	1½ — 2	1½	...
150,000*l*	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	..	100 —105	100 —105	..	...
64,248	Western and Brazilian Teleg., Ltd.	15	2½%	2½%	3 %	10 — 10½	10 — 10½	10⅜	10
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	6½ — 7	6½ — 7	6⅝	...
33,129	Do. do. do. Def. Ord.	7½	...	...	1 %	4 — 4½	3⅞ — 4½	...	...
165,200*l*	Do. do. do. 6 % Debs. "A," 1880 Red.	100	6 %	6 %	6 %	103 —107	104 —108	...	...
206,400*l*	Do. do. do. do "B," do.	100	6 %	6 %	6 %	103 —107	104 —108	...	...
88,321	West India and Panama Teleg., Ltd.	10	⅛%	⅞%	⅛%	⅝ — 1	⅝ — 1	1/16	⅝
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	10⅛ — 10⅜	10⅛ — 10⅜	10⅛	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	8½ — 9½	8½ — 9½	...	...
80,000*l*	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	5 %	110 —113	111 —114	...	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7 %	113 —118	113 —118	...	...
164,300*l*	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6 %	100 —103	100 —103	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	5 %	4½%	4½%	5¼ — 5⅜	5¼ — 5⅜	...	...
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	...	...	...	7 — 7¼	6⅞ — 7¼	...	...
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	...	...	116 — 119	116—119	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	...	5 %	13 — 14	13½ — 14½	14¼	13⅝
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	14½ — 15½	14¾ — 15½	15⅜	15
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	133 —137	133 —137	136½	135
22,475	County of London and Brush Prov. Elec. Ligtg., Ltd., Ord. 1—22,475	10	..	...	...	8½ — 9½	8½ — 9⅛	9 1/16	...
10,000	Do. do. do. 6% Pref., £6 pd., 40,001—50,000	10	...	..	...	6⅞ — 7¼	8⅜ — 9¼	...	...
50,000	†Liverpool Electric Supply, all paid	5	5 %	5 %	5⅛%	7⅞ — 8⅛	7⅞ — 8⅛	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	2 %	2½%	3 %	11⅜ — 12¼	11¼ — 12	11⅜	...
150,000*l*	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	117 —119	117 —119	119	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	..	...	1 %	8½ — 9½	8½ — 9½	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	7½%	4½%	6½%	8 — 8½	8⅛ — 8⅜	8½	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 9½	9 — 9½	...	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	3½%	4 %	5 %	8½ — 9	8½ — 9	...	...

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. § Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation, Oct. 2nd.	Closing Quotation, Oct. 9th.	Business done during week ended Oct. 9th, 1895. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	3	6 % §	6 % §	...	1½— 1⅝	1¼— 1⅜	1⅜	1½
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 % §	6 % §	...	1⅝— 2⅛	2 — 2¼	2 3/16	2
125,000£	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	4½%	...	112 —115	112 —115	...	...
630,000£	City and South London Railway	Stock	8%	8%	1¼%	38 — 40	38 — 40	40	38
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	7 % §	7 % §	...	1 — 2	1½— 2	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	...	...	5 %	2 — 2¼xd	1⅞— 2¼	...	...
100,000	Do. do. do. 4½% Deb. Stock Red....	Stock	...	...	4½%	104 —107	104 —107	106½	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	*nil*	*nil*	⅝— ¾	⅝— ¾	⅝	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	7 %	2 — 2¼xd	2 — 2½	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	¾ — 1	¾— 1	...	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	⅝ — 1⅛	¾— 1⅛	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	...	⅛— ⅜	⅛— ⅜	...	...
9,600£	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	*nil*	...	6½— 7½	6½— 7½		
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	5 %	6 %	12½— 13	13½— 14	13⅜	13
3,000	Do. do. do. 7% Pref.	10	...	...	...	15½ — 16½xd	15½— 16½	16⅜	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	...	...	104 —107	105 —108	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	10 %	19 — 21	19 — 21	20	19⅜
200,000£	Do. do. do. 4½ % Deb., 1896	100	4½%	4½%	4½%	100 —102xd	100 —102	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	1 %	1½%	12⅛—12⅜	11⅞— 12⅛	11 31/32	...
10,000	† Do. do. Pref., £10 paid	10	...	5 %	5 %	15 — 15½	15 — 15½	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	20 %	20 %	43 — 45	43 — 45	44½	43
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	104 —107	104 —107	...	...
54,000£	Waterloo and City Railway, Nos. 1 to 54,000, £4 paid ...	10	...	...	...	4⅛— 4¼	4⅝— 4⅞	4⅜	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7%; 1890—8%

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅛—6¼.

Electric Construction Corporation, 6 % Debentures, 95—100.

House-to-House Company (£5 paid), 4¼—4⅜.

Do. do. 7 % Preference, of £5, 8—8½.

Do. do. 4½% Debentures of £100, 110—112.

Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 8—8½; 1st Preference Cumulative 6 %, £5 (fully paid), 7—7½.

Liverpool Electric Supply, £5 (fully paid), 6⅞—7⅛.

London Electric Supply Corporation, £5 Ordinary, ⅜—⅝.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 6⅞—7.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

GENERATION AND DISTRIBUTION OF ELECTRIC POWER FOR MANUFACTURING PURPOSES.*

By C. A. STONE and E. S. WEBSTER.

One of the principal questions of interest to the manufacturer to-day, is whether or not by the adoption of electric devices, in one form or another, he can effect a saving in driving the machinery of his mill.

Many forms of machinery can now be driven directly by electric motors, and recent discoveries in electrical science, and improvements in existing types of apparatus, will, probably before long make it possible to drive nearly all forms of mechanical devices directly by electric power without the use of countershafts.

As illustrating the amount of power consumed in driving the shafting of an ordinary machine shop, it will be of interest to refer to the accompanying curve, which shows the total horse-power required in driving the machinery of an ordinary stamping mill. To obtain this curve, indicator diagrams were taken at the engine at various intervals throughout the day, and at noon when all the machinery was shut down, excepting the countershafting, a series of cards were taken to determine the actual power required to overcome the friction, which, as can readily be seen from the curve, amounted to more than 60 per cent. of the entire work done. As a matter of fact, the actual average indicated horse-power throughout the day was $62\frac{3}{10}$ths, and the average friction load $39\frac{6}{10}$ths, including engine friction, which amounted to about six horse-power. From this it will be seen that in order to furnish about 23 horse-power to be used in actual work, it was necessary to produce over 62 horse-power, including engine friction. Of course, no electrical method of driving would save the six horse-power lost in the engine, but it is unquestionably true that a very considerable proportion of the remaining $33\frac{6}{10}$ths horse-power lost in shafting and belting could be saved by the direct application of motors to the machines themselves. Even allowing that in an electric transmission scheme of this sort, involving the use of small motors, an actual commercial efficiency of only 60 per cent. could be secured, still, we should be obliged to supply only 44 indicated horse-power, assuming the engine losses to be the same. This application of small motors directly to machines has been increasing considerably during the past few years, and there are now a number of manufacturing establishments where they have been introduced extensively.

Motors specially constructed for direct application to different forms of machinery require much thought and attention to build, and at best some experimental work is necessary to secure perfection in operation and control, but there are at least five well-defined cases where electric power transmission can always be used to advantage with standard forms of electrical apparatus. These cases may be roughly outlined as follows:—

1st. Where a large water-power is available at a considerable distance from a mill which is in need of more power than can be obtained from the water privilege at the mill itself.

2nd. Where, owing to the separation of mill buildings, it is desired to transmit power further than can be done by belting, in order to avoid the installation of individual steam plants in each building.

3rd. Where small water privileges are available at various points along a stream, but in order to become useful the power must be concentrated at one point without too great expense for maintenance and operation of the individual parts of the system.

4th. Where for various reasons in selecting a mill site it is desirable to locate at a considerable distance from the

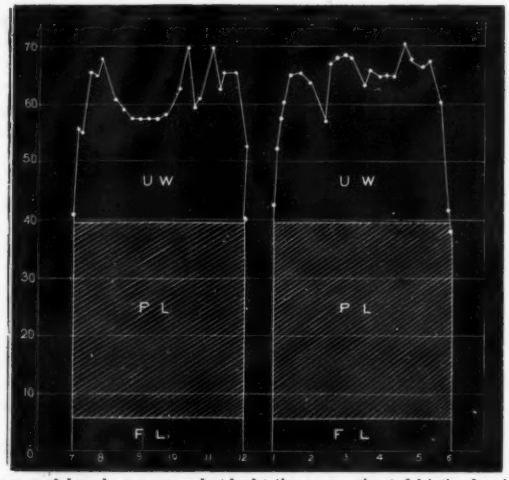
* Abstract of a paper read before the New England Cotton Manufacturers' Association.

source of power, usually on account of the fact that the land immediately adjacent to the privilege is not suitable as a location.

5th. Where, for special reasons, it is important to do away with shafting throughout the mill, and to avoid on account of fire risk or other reasons the ordinary belt holes between floors. That results can readily be accomplished is best demonstrated by the fact that there are in daily operation throughout this country, plants which are fulfilling every requirement. Take, for example, the first case which we have outlined, in which a water power is available at a considerable distance from the mill where the power is required, there are, perhaps, fifty plants in regular operation in this country which fall under this head; at least six different systems of transmission are in use for work of this sort, and in places where plants have been properly installed each is giving good results. One of the earliest long-distance transmission plants of this sort which was equipped, was that built by the Westinghouse Company for the San Miguel Mining Company, at Telluride, Colorado.

Admitting, then, that power can be transmitted satisfactorily, the next important point is the economy of the electric transmission.

To get a general idea of the cost, let us take the case of a water privilege with 1,000 horse-power available, situated at a distance of two miles from a mill where this amount of



U W, useful work; P L, power lost by friction; F L, estimated friction loss in engine. Power test, average I.H.P. 62·34; average friction, 39·6; engine friction, est., 6.

Curves Showing Relation of Useful Work and Friction.

power can be used to advantage. We shall assume that the cost of power ready to be delivered to the dynamos is $12 per annum, including all charges for interest, depreciation, and attendance of the hydraulic part of the system. The commercial efficiency of transmission will not be far from 80 per cent., so that if we are to start with 1,000 horse-power we shall not be able to deliver over 800.

The cost of electrical machinery for a plant of this size would amount to about $23,000, and the interest, depreciation, repairs and supplies may be conservatively estimated at $2,500 per annum.

The necessary pole line, wire, accessories, and labour of installation would cost about $13,000, and interest and depreciation on this should be figured at eight per cent., which gives an annual expense of $1,040. One man will be required at either end if a 10 hour run is made, and two men if a 24 hour run is made. In the first case the cost of attendance would amount to $1,200 per annum, and in the second case to $2,400 per annum. On the basis of these figures, which practice has demonstrated are substantially correct, we find that the cost per horse-power delivered for the electrical part of the system amounts to $6.30 for a 10 hour run, and $8 for 24 hour run, to which must be added $15 per useful horse-power for the cost of the water-power, making a total of $21.30 and $23 respectively for ten and twenty-four-hour runs. These figures are unquestionably less than those at which steam power could be furnished, except under extremely favourable conditions.

It often happens that in a manufacturing plant the mill buildings are so far separated that it is impracticable to transmit power by means of shafting or belting, and in such a case it is often desirable to instal an electric transmission plant, to avoid the necessity of placing separate steam plants in each building.

In order to see approximately what can be done in a case of this sort, let us suppose that we have two mill buildings situated, say, 1,000 feet apart, and that in one mill we require 500 horse-power and in the other mill 100. Under such conditions the ordinary custom would be to instal separate steam plants in each mill, but if by generating all the power at one point, instead of at two, we can effect a sufficient saving to more than pay the interest, depreciation, and maintenance for an electric transmission plant, we can clearly effect a saving in total cost of operating.

With coal at $5 per ton, using a compound condensing engine, the extra cost per annum of generating 600 horse-power ten hours per day over that of generating 500 horse-power, would be about $1,400, whereas the 100 horse-power alone could not be produced for less than $30 per horse-power per annum or $3,000. We could, therefore, afford to pay $1,600 for interest, depreciation, and maintenance of a suitable electric transmission plant for delivering 100 horse-power, without increasing our total annual operating expense. Careful figures show that the interest, depreciation, and maintenance of such a plant would not amount to over $800 per annum, so that this is evidently a case where an electrical transmission plant would effect an $800 saving to its owner.

There are many cases of mill properties, especially in New England, where small water privileges are available, varying in size perhaps from 50 to a 100 horse-power or over.

That such properties can be made use of to great advantage has been clearly demonstrated by the successful operation of a small plant which we installed some three years ago for the Samson Cordage Company at Shirley, Massachusetts. This company has a mill requiring some 200 horse-power to drive, situated on the Nashua River in Shirley, and as the available water power at the mill site was only about 150 horse-power, it was formerly necessary to supplement this by steam in order to obtain power enough to drive the machines. At a distance of about quarter of a mile up stream was another mill, now the property of the Samson Cordage Company, which was originally owned by the Shakers of the Shirley settlement, and operated as a cotton mill, but had some time before fallen into disuse. This mill has a water privilege of from 50 to 75 horse-power capacity, and it was decided to instal an electric transmission plant, with the idea of conveying the power to the cordage mill.

The problem, accordingly, as it was presented to us, was to design and instal a plant the dynamo of which should be readily controllable from the motor station, and which should be so arranged that the motor would drive on to the main shaft in parallel with the water wheel at the mill, contributing its portion to the whole amount of power required. A 500-volt system was finally decided upon, and a 50 horse-power dynamo and motor installed at either end, with extra field wires leading from the dynamo to the motor station, so that the dynamo itself would be under control at all times of the man in charge at the mill. Further than this, an artificial load was provided which could be thrown in parallel with the motor or used to entirely replace it. With these precautions it has been found that the water wheel and dynamo require very little attention, and that practically entire control is obtained from the motor end, where, by an adjustment of the field resistance of the dynamo, the motor can be made to contribute any amount of power to the main shaft from nothing up to full load. Further than this, in case of trouble with the remaining part of the driving system, which might cause an unduly heavy load to be thrown upon the motor and thus injure it, a provision was made for tripping a circuit breaker which cuts out the motor and allows it to come to rest, but at the same time throws in the artificial resistance before mentioned, which brings an equal load upon the dynamo and prevents the racing of the water wheel.

In the case of this plant the only expense for the 50 horse-power delivered, is that due to the interest on investment, depreciation, repairs, and maintenance. This amounts to less than $15 per horse-power for the power actually delivered, and as steam power under existing conditions would at best cost $40 per horse-power, the electric system under the conditions mentioned clearly effects a saving to the owner of $1,250 per annum.

THE VARIATION IN THE ELECTRICAL RESISTANCE OF BISMUTH, WHEN COOLED TO THE TEMPERATURE OF SOLID AIR.*

By JAMES DEWAR, M.A., LL.D., F.R.S., Professor of Chemistry in the Royal Institution, &c., and J. A. FLEMING, M.A., D.Sc. F.R.S., Professor of Electrical Engineering in University College, London.

(Concluded from page 404.)

Similar experiments made with pure antimony drawn up into glass tubes did not show the appearance of any minimum resistance for any temperature between 0° and — 200° P_1. In no other case amongst all the metals and alloys examined by us has any phenomenon presented itself similar to that shown by the above specimens of pure bismuth. So far, therefore, as these investigations have gone, they show that the behaviour of bismuth at low temperatures in respect of electrical conductivity is anomalous. The temperature-resistance curves of these specimens are quite different to those of other pure metals. In our first communication on the electrical resistance of metals (see *Phil. Mag.*, October, 1892) we showed that carbon taken in the form of a carbon filament from an incandescent lamp increases its resistance continuously when cooled down to the boiling-point of oxygen, and we suggested that for pure non-metals continual lowering of the temperature towards the absolute zero would in all probability continually increase the specific electrical resistance. In the specimens of pure bismuth, A and B, there is no indication at the lowest temperature reached, viz., — 235° P_1, that the resistance lines for this pure bismuth would have another point of inflexion. If, then, the specific resistance of these samples of pure bismuth goes on increasing continuously down to the absolute zero of temperature, as it would appear to do, in that respect they behave like a non-metal, having, however a very much larger temperature coefficient than carbon. The behaviour of bismuth in a magnetic field in regard to electrical resistance, and also the fact that different specimens of bismuth have in some cases positive and in other cases negative temperature coefficients at temperatures above 0° C., has been examined by other observers. Without entering into any historical statement of the course of investigation in this matter, brief reference may be made to two papers on this subject which have a bearing on the facts here described by us. In 1886 an experimental study of the influence of magnetism and temperature on the electrical resistance of bismuth, and also of its alloys with lead and tin, was described by M. von Aubel (see *Phil. Mag.* 1888, 5th series, Vol. xxv., p. 191). He studied the electrical resistance of certain specimens of pure bismuth in the form of rods slowly cooled, and for temperatures between 17°·2 C. and 70°·8 C. found a negative coefficient for some of these specimens. In the case of rods of pure bismuth which had been tempered between temperatures 15°·2 C. and 69°·7 C., he found a positive temperature coefficient within these limits; that is to say, in the first case heating the bismuth decreased its resistance, and in the second case heating the bismuth increased its resistance between the stated limits of temperature. In none of the samples of bismuth examined by us have we found a negative temperature coefficient for temperatures above 0° C.

For a certain specimen of compressed bismuth wire M. von Aubel found the resistance practically constant between 16°·8 C. and 76° C.; but on melting, cooling, and annealing the same specimen it acquired a positive temperature coefficient between these limits. M. von Aubel examined the electrical resistance of certain bismuth-lead-tin alloys, and he came to the conclusion that the cause of these anomalies in the temperature coefficient of bismuth was the varying physical condition of the bismuth, and not the presence of impurities. In 1894 Mr. J. B. Henderson published a paper "On the Effects of Magnetic Fields on the Electric Conductivity of Bismuth" (see *Phil. Mag.* 1894, 5th series, p. 488), and he gives a series of curves showing the temperature variation of bismuth when taken in magnetic fields of different strengths. For a certain specimen of bismuth wire, and for a certain magnetic field-strength of about 10,000 C.G.S. units, his curves indicate a point of minimum resistance for the bismuth. Taking the bismuth at a certain temperature, the temperature coefficient at that point in a zero magnetic field was found to be positive; but on gradually increasing the strength of the magnetic field in which the bismuth was immersed the temperature coefficient finally became negative. One point of interest, then, in connection with these investigations is whether the specific resistance of bismuth always presents a minimum value, and whether the temperature at which this minimum value occurs depends upon the strength of the magnetic field in which the bismuth is immersed, as well as upon the physical condition of the metal. In the case of the two wires of pure bismuth, "A" and "B," used by us, the diameters of the wires were different, and the pressures under which they were formed, and therefore the physical condition in the interior of the wire, was no doubt also different. Hence although both these wires present a point of minimum electrical resistance, the temperature at which this occurs is not identically the same. Another point of interest is that the temperature at which a discontinuity was found by us in the thermo-electric line of the pure bismuth, and which was found to be about —80° C., is also approximately the point at which the resistance temperature coefficient of the same bismuth becomes sensibly negative. It is therefore clear that at this temperature a critical point is reached for this particular sample of bismuth, and below this point the bismuth undergoes a physical change which affects its thermo-electric value as well as its resistance temperature coefficient. These investigations indicate that the electrical behaviour of bismuth in certain states at and below particular temperatures is irregular, and that further study is necessary to arrive at a complete explanation of the facts. It has been pointed out by one of us (see Friday evening discourse at the Royal Institution, by Prof. Dewar, "On the Scientific Uses of Liquid Air," January 19th, 1894), that the tensile strength of very many metals is greatly increased by cooling them down to the temperature of liquid oxygen, but that there is a very marked decrease in the tensile strength of bismuth as well as of antimony and some other metals when taken down to the same low temperature. It is interesting to note that bismuth, which, at any rate in certain states, presents the anomaly of a discontinuity in its curve of thermo-electromotive force at a certain low temperature, has also at about the same temperature a change of sign of the temperature coefficient, and becomes in addition exceedingly brittle below that temperature.

In an interesting paper on the "Mechanism of Electrical Conduction" (see *Phil. Mag.*, ser. 5, 1894, Vol. xxxviii., p. 57), Dr. C. V. Burton makes reference to our former experiments on the resistance of pure metals, and states and proves a theorem to the effect that at the absolute zero of temperature every substance must have either infinite specific resistance or infinite conductivity. In the samples of bismuth, A and B, we have before us a material which exhibits, as far as we can judge, a tendency in its specific resistance to continually increase as it is cooled to temperatures lying below about — 80°. In this respect it resembles a non-metal, and the question arises whether this is the proper characteristic behaviour of pure bismuth, or whether in any other physical condition it would show the normal quality of pure metals in decreasing its specific resistance regularly as it is cooled towards the absolute zero.

With the object of ascertaining this we have also tested some very pure bismuth kindly sent to us by Mr. Edward Matthey, and which was prepared by the reduction of the oxychloride. This being pressed into wire was found to give a resistance temperature curve very similar in general form to that marked Griffin's bismuth in Plate V. The resistance decreased down to about 0° C., and then increased again when cooled to about — 160°, and finally decreased again. It is clear, therefore, that the specimens of bismuth, viz., that prepared for us by Mr. George Matthey from the oxide and that prepared by Mr. Edward Matthey from the oxychloride, and which are both very pure, behave quite differently at very low temperatures with regard to their electrical conductivity. We have also examined the variation of a sample of bismuth prepared electrolytically, but the result of this examination we reserve until the observations have been confirmed on other samples of electrolytic bismuth.

* From the *Philosophical Magazine* for September, 1895.

One fact of considerable interest has presented itself in studying the action of a magnetic field on the electrical resistance of bismuth cooled to low temperatures. It is well known that the electrical resistance of bismuth is increased by being immersed in a magnetic field. Taking a sample of the pure (Matthey) bismuth wire, we measured its electrical resistance at 18° C. in the earth's field and when placed transversely in the field of an electro-magnet, and found an increase of resistance due to the field in the ratio of 1·361 to 1·434, or about 5 per cent. The same sample was cooled in liquid oxygen, and measured again in the same fields. The resistances were then in the ratio of 1·478 to 1·858. The increase in resistance in this last case is nearly 25 per cent. Hence the cooling of the bismuth to − 182° C. increased the effect of a given magnetic field in altering its resistance about five times.

Another experiment was made to ascertain whether increased pressure on the surface of the bismuth affected its resistance. When a sample of pure bismuth wire was subjected to an external surface pressure of 300 atmospheres, a very slight but definite increase of resistance was found, which disappeared instantly on removing the pressure.

The above described observations show that there is a very marked difference between different samples of bismuth as regards electrical resistance when subjected to very low temperatures, and that its behaviour at these temperatures in magnetic fields is also abnormal. We propose to reserve further remarks on this subject until we have completed the experiments in progress on electrolytic bismuth. We expect then to be able to state the results obtained for specimens of bismuth of known chemical purity, and to distinguish between those effects which are due to physical condition and those, if any, arising from the presence of minute traces of impurity.

STEAM ENGINES OF TO-DAY.

The Chicago exhibition appears likely to have a considerable permanent effect in America. Large numbers of the people living as they do, in the middle of a great continent and shut out by tariffs from any knowledge of the outer world other than that gathered from the native press, which depicts Europe as sunk in the depths of pauperism and peopled only by half-clad, semi-starving savages, were brought face to face with the productions of these same savages, and the result cannot have been other than educational.

We do not wish to class Mr. Clark, the author of the article with the above title in *Cassier's Magazine*, with those who know not Europe, but his article, all the same, represents something of the newly aroused interest in the outside world among the Americans. Of the engines described a sectional arrangement by the Fulton Works of San Francisco commands a notice. Its size is 18 inches by 36 inches, and no part, except the crankshaft, weighs more than the conventional 300 lbs. to which English engineers who export machinery have become habituated as representing the load for a mule. The illustration shows how the idea has been carried out, the fly-wheel being built up of a segmental rim and 16 round arms, the crank pedestal of five separate pieces, and the cylinder of nine or more pieces, the barrel alone being in five lengths, first fitted together and then bored. The strains are taken up by tie bars between the cylinder front cover and the shaft pedestal, the tie bars serving the purpose also of guides for the crosshead. A vertical engine by Westgarth, English & Co., of Middlesborough, is illustrated. It has a Proell gear arranged to cut off steam, and placed before the high-pressure distribution valve. Expansion thus affects the steam in the valve chest, but the use of a Corliss type of valve enables the clearance space to be kept small. The low-pressure valve is of double-ported Corliss, having a passage through it to give greater port opening with reasonable oscillation.

The next illustration is of a triple expansion vertical direct-driving dynamo engine, by Robey, with a fly-wheel governor, cylinders 8¾ inches, 14 inches and 20 inches by 9 inches stroke, designed to run at 310 revolutions and to indicate 120 H.P. with 150 pounds steam. The piston speed is thus 465 feet and all the cylinders are jacketed. The illustration indicates attention to the question of lubrication and solid construction and accessible parts, the front being open, with removable crank splash guards. An American engine illustrated and well described is the Thomson flat Corliss valve engine in which the trip gear with knee or toggle joint release is made to actuate flat valves in place of the cylindrical Corliss valves of ordinary type. There is the usual accompaniment of dash-pots and the tripping of the toggle is effected by means of a roller, carried on an arm projecting from the toggle, this roller running up an inclined wedge, whose position is varied by the governor. One eccentric moves all four valves, the exhaust being simple slides without trip motion.

Another four-valve engine of new design is the "cycloidal." In this engine the valves are long multiported slide valves with short travel actuated by a cycloidal cam on a rocker arm and placed in the same way as a Corliss ordinary valve. The back stroke of the back is effected by a small steam piston and there are no dash-pots or springs. The valve seats are cylindrical in two longitudinally split halves, the split being slightly oblique so that the seats can be firmly secured by the wedge action. The valve face is flat and works on flat faces inside the seating shell, the valve itself having two faces like a V and working in similar faces *in* the seating. The exhaust valves are reversed, Λ, and sit *upon* a Λ seating. These valves are, in fact, long and narrow gridiron valves. When closed there is ⅛th inch of lap round each port and the movement is only ⅜ths inch for full opening. We should expect these valves to be durable and to be heard of in the future. The high-pressure cylinder alone is jacketed, as "experience is against the economy of jacketing the low pressure cylinder." This at least is the experience of many engineers with ordinary methods of jacketing, though it is a subject that deserves further investigation.

In the Mengeringhausen valve gear the valves are actuated by means of a wrist plate with a slotted cam roller path. This is really only a cam motion of the type common in textile machinery, a portion of the groove being concentric with the axis, and so giving the wait to the valve where wanted. We have seen the same thing applied to actuate a counter, but there is nothing very striking in the idea for moving a valve.

The illustration of a pair of tandem triple expansion engines with four cylinders by Daniel Adamson & Co., for Minerva Mill, Ashton, may be taken as a sample of the present fashion in cotton mill engines. With cylinders 22 inches, 36 inches, and two 40 inches by 6 feet stroke, a power of 1,500 is developed at 55 revolutions with 160 lbs. pressure. The piston speed is thus 660, and a 30 feet drum carries 40 ropes of 1½ diameter, the weight being 65 tons. The great length of the engine room with the bad perspective that emphasises it and seems to pass muster as artistic among the Lancastrian engineers, might be seized upon if it truly represented the engines, by the makers of high speed engines as a point to carp at.

Wheelock expansion gear is provided, which consists of a valve of Corliss type placed behind and close to the Corliss distribution valve, and both high and intermediate cylinders have automatically controlled expansion, each with a separate governor. There is also an electric stop motion, so fixed as to shut the stop valve in case of accident, and known in Lancashire as a knock-off motion.

Like most large factory engines there is a barring engine of the type similar to those described in another article in the same number of *Cassiers*.

STAFFORD ELECTRIC LIGHTING.

There are a few more details of plant and mains which we were unable to include in our recent description of this station.

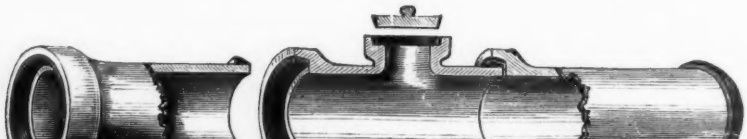
The mains are drawn into glazed stoneware pipes, four inches in diameter, of Doulton's manufacture, and fitted with their patent joint. As stoneware pipes with this type of joint have recently been extensively used as underground electrical conduits (notably at Manchester and Oswestry, as well as at Stafford), the accompanying illustration and des-

cription will be of interest. Ordinary stoneware pipes form a cheap and imperishable conduit for electric mains, and instances of their satisfactory use for this purpose exist at Norwich, Ealing, Whitehaven, Derby, Woking, &c. One drawback to their more extensive adoption, however, is the difficulty of readily making a reliable joint. The Doulton joint requires the minimum of time, skill and labour in making it. It is practically an artificial bored and turned joint formed by casting on the spigot and in the socket of each pipe, rings of a durable material, which, when put together, fit mechanically into each other and form a water-tight joint without the use of any cementing material. By making these rings of a spherical form, a reasonable amount of movement or settlement may take place without destroying the soundness of the joint. The pipes having been put together, the trenches may be at once filled in, which is an obvious advantage where traffic is being interfered with.

At Stafford the pipes entering the distributing boxes are formed with bell mouths to facilitate the drawing-in of the cables.

The furnaces that have been attached to the boilers are those known as the "Meldrum" forced draught, which are now being extensively adopted. We have in former issues spoken of the advantages of this form of furnace.

The makers have recently introduced an improvement by which, what we should consider the only drawback to the universal adoption of this system at electric supply stations,



Doulton's Stoneware Pipes with Patent Joint.

has been overcome, and that is, the noise occasioned by the inrush of atmospheric air and steam through the blowers. This has been entirely obviated by means of an ingenious contrivance for obtaining the needful air supply through special tubes passing through the foot plates.

We understand that the boilers at the Islington electric supply station, which are to be supplied with the "Meldrum" furnaces, are also to be similarly fitted with this special improvement.

PHASING TRANSFORMERS.*

By CHARLES S. BRADLEY.

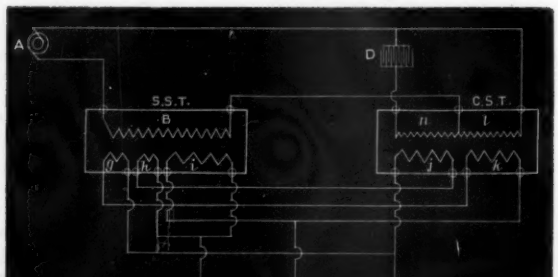
On account of the large number of single-phase plants in existence which were built for lighting, and with no thought at the time of running motors from these systems, it has seemed to the electrical engineer very necessary to produce a single-phase motor. Many talented men have laboured and studied upon this subject, and, so far, the results have not been at all satisfactory.

During the last few years, the rapid progress of the polyphase motor has been the only success. The evolution of electrical art seems to be toward the production of apparatus which shall make all systems mutually convertible, so that we may be able to convert the phases produced into a greater or lesser number; starting with a generator of three phases, we shall be able to produce from it two or one. Again, generating two phases, we shall be able to convert it into three phases or one. Again, starting with a single-phase generator, we shall be able to convert it into two or three phases.

The polyphase motor is so good as to need but very little, if any improvement, but this is so familiar to the Institute, that I need not go into details. I think the time is not far distant when we shall be able to fill out with the alternating currents any engineering problem that may be required of us. We will be able to take old plants and modify them to do any work which may be necessary. One of the important links to round out the art, seems to be the phasing transformer, so that we can take a single-phase alternating current, and convert it into polyphase of any desired number.

I have chosen for my work the conversion of single-phase to three-phase, because the three-phase motors which we have been able to construct give us very much less trouble than the two-phase. In a series of experiments, I have found that the two-phase motor would run at a number of speeds, especially when supplied with current from a phasing transformer. I supposed the trouble arose from harmonics, but of this I am not certain. The triphase motor never has given us any of this trouble. These experiments, however, were carried out before the transformers had been refined; and, now that we are getting more perfect results, I think it is very probable that we could return to the two-phase motor and get much better results than when first tried. The following is a description of an arrangement of condensers and cores to produce polyphase and single-phase alternating currents. Many different arrangements of condensers and inductances have been tried, and all have failed to keep their phases at a working relation, except the one I am about to describe.

A diagram of the phasing transformer and connections with the generator and motor, will be found in fig. 1, A being the generator, B the simple section of the transformer, D the condenser, and M the motor; r, primary of the simple section of the transformer; n and l, primary of the compound section; g, h, and i, secondaries of the simple section of the transformer, and j and k secondaries of the compound section. The primary of the simple section of the transformer is in series with the compound section and condenser. By the proper adjustment of capacity and inductance, the magnetic



S S T, simple section of transformer; C S T, compound section of transformer.

Fig. 1.

flux in the core of the compound section is approximately 90° in phase behind the simple section; then, in order to get three phases from the two, I resort to resultants in the secondaries; g and k constitute one phase, h and j a second, and i the third. The essence of this invention rests in the arrangement of the compound section of the transformer and condenser. There are, undoubtedly, several ways of explaining the theories involved in this device, and most people would prefer the mathematical description, but, as I did not hit upon the invention by that method, I shall follow in the explanation the same method of reasoning as I used to arrive at the result. In order to explain the theory

* A paper presented at the 99th meeting of the American Institute of Electrical Engineers, New York and Chicago, September 1895. (Subject to Revision.)

involved in this, refer to fig. 2, in which A is the generator, E the inductance, D a condenser or capacity, *l* and *n* represent the leads to the inductance, E, and to the capacity, D. If the generator is generating an electromotive force in the direction of the arrow, fig. 2, a current will flow through the

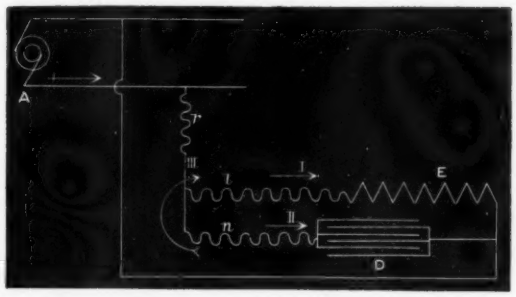


FIG. 2.

lead, *l*, and the inductance, E, as represented by the arrow prime, and through *n* into D, in the direction of the arrow second, as indicated by the curves in fig. 3; that is, during the rise of the electromotive force through the machine from the point, *o*, to the top of the wave at *p*, the current will flow in parallel into or through the inductance, E, and the capacity, D, fig. 2. As soon as the wave of the electromotive force commences to decline from the point, *p*, the condenser will begin to discharge, and the current flowing from it will be in the direction of the arrow third, fig. 2. Also, at the same time, the inductance will discharge its energy by a current in the direction of arrow third, so that the current represented by arrow third will cross the zero line at point, *t*, fig. 3, or is delayed by a time equal to 90°. Thus we see that the current represented by arrow third will be lagging in its time period considerably behind that in the lead, *r*, represented

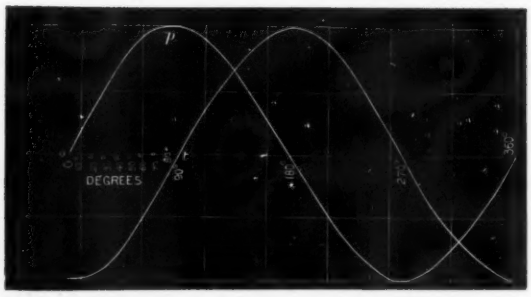


FIG. 3.

by curve *o*—*p*. Now, if we wind the lead, *l*, and the lead, *n*, upon the iron core, as shown in fig. 4, in opposite directions, and of the same number of turns, and have the inductance, E, bear a proper relation to the capacity, D, so that the currents represented by arrow prime and arrow second shall be equal, no magnetic flux will be produced in the core during the rise of the potential of the machine from *o* to *p* on the curve; but during the fall of the electromotive force of the machine, and during the discharge of the inductance and condenser which is represented by arrow third, fig. 2, the currents flowing through *n* and *l* will be in series, and flowing in the same direction; consequently, the magnetic flux will be approximately 90° later than it would be if charged directly from the machine. I have represented in fig. 2 a a section of lead by *r*, and it will now be clearly seen that the current in the lead, *r*, will have a phase difference from the combined or resultant phases in the leads *l* and *n*. Furthermore, a current in the lead, *r*, will be in lead of the electromotive force of the machine, because the inductance and the condenser, previously described, cut off the flow of the current before the machine has reached the zero point, and when the lead, *r*, is placed upon an iron core, as shown in fig. 4, it has a tendency to lag, which counterbalances the lead, and leaves the main line current somewhere near in phase with the E.M.F. of the generator.

Please refer now to fig. 4, where the leads, *l* and *n*, are wound in opposite directions, and completely interlaced upon the iron core, L, the generator, inductance and capacity being indicated by the same symbols as in previous figures. The lead, *r*, is here wound upon the second iron core, which constitutes the primary of the simple section of the transformer, as shown at B, fig. 1. In reducing to practice, and applying the transformer to an induction motor, we find that the inductance, E, can be dispensed with, as the apparent inductance produced by the motor furnishes all the lag necessary, and it will be noted that in fig. 1 the extra inductance which we used in our first experiments, is left out of the combination. The lead from the simple section of the transformer, it will be noted, goes to the centre of the compound section. This diagram does not represent the true condition of the compound section, for the winding, *n* and *l*, are together, or, as before mentioned, interlaced upon the core. The magnetic

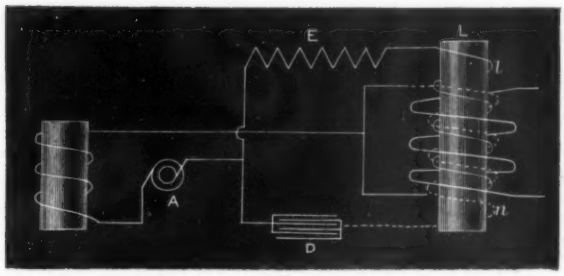


FIG. 4.

flux in the two sections of the transformer are approximately 90° apart. The secondaries are therefore wound each partially upon the two cores, so that the three resultant phases may be produced from two, this being in accordance with Mr. Fred. S. Hunting's invention for changing two phases to three. For the description of this I will quote Mr. Hunting's own words, and the plan is in fig. 5.

"If P^1 and P^2 represent two primary circuits supplied respectively with alternating currents differing in phase, or disposed in any other suitable manner, so that the fluctuating magnetic impulses developed in the cores, M^1 and M^2, differ in time, then the secondary currents developed in circuits S^1 and S^2 will differ in time period. If other circuits, as S^3 and S^4, be so arranged, that part of their convolutions will enclose one magnetic core and part another, there will be developed in these circuits a resultant current due to the combined action of both magnetic cores, and this current may be given any desired degree of phase diaplacement with reference to the current in primary coils, P_1 and P^2, accordingly as the number of convolutions surrounding the respective

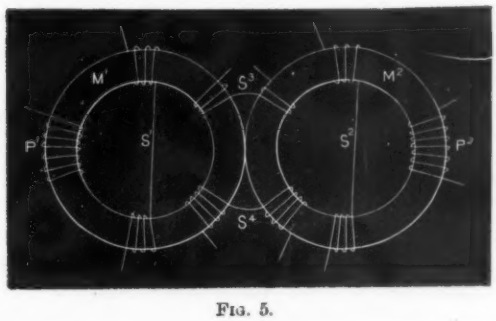


FIG. 5.

cores is varied. For example, if, as shown in circuit S^4, an equal number of convolutions is placed around each core, then there will be developed in circuit S^4 a resultant current having its phase half way between the phase of current in coils P^1 and P^2. If the number of convolutions on the two cores vary in the proportion of three to two, and be joined together as indicated by the coils S^3, the resulting current produced by these coils will be closer in phase to the current flowing in P^1, providing the larger number of convolutions be placed as indicated in the diagram upon the magnetic

core controlled by coil P^1. Thus, by varying the relative proportions of the two coils inclosing the two magnetic circuits, a resulting current of any desired phase displacement with reference to the phase of coils P^1 and P^2 may be developed. It will thus be seen that by means of two magnetic circuits or cores in which magneto-motive forces differing in phase are developed, we may produce any desired number of currents of differing phase, and may produce a definite degree of phase displacement, and the resultant current may in any case be shifted closer to the phase of magneto-motive force in either core, by increasing the inductive influence of said core upon the circuit carrying the resultant current.

"In the organisation shown in the diagram, we will have four secondary currents developed from the primary coils, P^1 and P^2, and assuming that the currents flowing through these coils differ in phase, all of said secondary currents will differ in phase."

(To be continued.)

NEW PATENTS—1895.

17,734. "A new or improved electrical alarm and connections therefor." H. Landergan and G. C. Grahame. Dated September 23rd.

17,741. "A new or improved device for indicating the duration of telephonic conversations." R. V. Kerckhove. Dated September 23rd.

17,745. "Improvements in or relating to electrolytic cells." H. H. Lake. (Communicated by C. Hoepfner, Germany.) Dated September 23rd.

17,758. "An improved automatic electrical cut-out." M. E. Crowne and H. C. Fowler. Dated September 24th.

17,766. "Improvements in soldering or working aluminium." J. Swinburne and A. A. Beadle. Dated September 24th.

17,773. "An improvement in telephone fittings." E. M. Edelsten. Dated September 24th.

17,782. "The adjustable electric dial contact." G. Wall. Dated September 24th.

17,788. "Improvements in electromotors." D. Clerk. (Communicated by H. Lacy, L. F. Johnson, and W. J. Slacke, United States.) Dated September 24th. (*Complete.*)

17,790. "Improvements in electro-magnets and method of winding the same." D. Clerk. (Communicated by H. Lacy, L. F. Johnson, and W. J. Slacke, United States.) Dated September 24th. (*Complete.*)

17,791. "Improvements in dynamos." D. Clerk. (Communicated by H. Lacy, L. F. Johnson, and W. J. Slacke, United states.) Dated September 24th. (*Complete.*)

17,821. "Improvements in or connected with secondary batteries." F. King. Dated September 24th.

17,825. "A new or improved porous plate, body, or electrode." W. H. Beck. (Communicated by J. Johnson, J. H. Robertson, J. H. Crosman, and W. H. Jewell, United States.) Dated September 24th. (*Complete.*)

17,830. "Improvements in and relating to mechanism for electrolytically indicating the extinction of lamps and for analogous purposes." H. H. Lake. (Communicated by H. See, United States.) Dated September 24th. (*Complete.*)

17,864. "Improvements in or relating to electric indicators or annunciators." J. W. Hall. Dated September 24th.

17,871. "Improvements in compositions for protecting ships' bottoms against fouling, preserving wood, and shielding submarine electric cables from penetration by torpedo worms." W. L. Gunn. Dated September 24th.

17,878. "Improvements appertaining to road or other vehicles propelled by gas, steam, electric, or like motor mechanism." F. Lister. Dated September 25th.

17,918. "Improvements in the manufacture of incandescent electric or glow lamp." P. H. Baily. Dated September 25th.

17,919. "Improvements relating to telegraph and like poles." F. E. Garner and C. R. Bliss. Dated September 25th.

17,921. "Improvements in the manufacture and production of filaments for incandescent electric lamps." J. W. Swan. Dated September 25th.

17,924. "Electric smoke annihilator." R. W. Hill. Dated September 25th.

17,925. "Production of carbonate of soda and chlorine gas by electricity." R. W. Hill. Dated September 25th.

17,949. "An improved process for electro-copper coating ships' hulls in a dock." E. Kronke. Dated September 25th. (*Complete.*)

18,018. "Improvements in incandescence, electric, and gas lamps and lanterns." V. Croizat. Dated September 26th.

18,033. "Improvements in or relating to developing displaced magnetic phases and producing rotary magnetic fields." W. P. Thompson. (Communicated by C. S. Bradley, United States.) Dated September 26th. (*Complete.*)

18,034. "Improvements in oxidising lead and lead compounds for the construction of electrical accumulators." H. Leitner. Dated September 26th. (*Complete.*)

18,036. "An improved process for the preparation of electrodes for primary, secondary, and dry batteries." H. Leitner and E. Reicher. Dated September 26th. (*Complete.*)

18,038. "Improvements in and appertaining to electrodes." H. Leitner and E. Reicher. Dated September 26th. (*Complete.*)

18,065. "Improvements in the method of and means for electrically illuminating block dials and signs." J. Haynes and H. H. Hall. Dated September 27th.

18,152. "Improvements in telephones." R. Goldlust. Dated September 28th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1895.

6,652. "Improvements in the construction of electric accumulator plates." A. Duffek and B. Holub. Dated April 1st. The inventors manufacture a number of balls of lead or other suitable metal, or combination of metals. These balls are placed close together in a compact manner, so as to touch each other, and are partly enclosed in lead, together forming a plate, the lead being poured in a molten state between and partly surrounding the balls, so as to form a suitable frame thereto. 3 claims.

6,781. "A socket for electric glow lamp." The Edison & Swan United Electric Light Co., Ltd., and C. F. Proctor. Dated April 2nd. Claim:—A socket for electric glow lamp, consisting of a base of insulating material having two metal holders for the conducting wires and plungers secured to it by hollow screws in which the plungers and their springs are accommodated, substantially as described.

8,026. "Improvements in electric railway systems." J. M Faulkner. Dated April 23rd. Relates to an enclosed conduit, the top of which is covered by sectional exposed conductor plates. These plates are insulated from each other and divided into sections of suitable lengths so that each section is considerably shorter than one half of the length of each vehicle on the road. Each exposed conductor section has a point or pin in the conduit, and usually extending down from one end of the exposed conductor section. 20 claims.

8,049. "Improvements in or relating to electric alarm clocks." W. P. Thompson. (A communication by H. W. Knapp and L. E. Gerrety, both of Minnesota.) Dated April 23rd. Consists in surrounding the dial of the timepiece with a metallic ring, in which are arranged any desired number of contact fingers adapted to be thrust inward into position to be touched by the hour hand of the timepiece, the operating parts of the timepiece and the ring in which the fingers are arranged being connected respectively with the opposite poles of an open circuit battery. Means are also provided for attaching tags or other marking devices to the contact fingers which indicate the character of the call or alarm. 8 claims.

8,147. "Combined trolley and accumulator system for driving electric cars." T. Nees. Dated April 24th. Consists of a process for combining the trolley and accumulator systems, for driving tramcars by electricity. 1 claim.

8,226. "Improvements in and relating to electric batteries." J. von der Poppenburg. Dated April 25th. Comprises a zinc and carbon cell, provided with a dry filling, and designed to remain in an inactive state, until it is to be used as its exciting material, will not be moistened before that time. For enabling the water or other exciting liquid to be quickly received and distributed in the exciting space or chamber, the jar of the cell, which is otherwise closed, is provided with one or more admission openings, and has, in the upper part of its interior, an empty space. 2 claims.

8,590. "Improvements in magnetic ore separators." J. W. Carter. Dated April 30th. Consists of an ore separator in which a series of permanent magnets is arranged below the supply-hopper in such a manner that the lower pole ends are receding below the upper pole ends, which latter are in the path of the falling material, that is conducted from the hopper over a magnetic deflecting plate that is arranged above and at a short distance back of the upper pole-ends of the magnets, so that the magnetic ore-particles are separated from the non-magnetic particles in their passage over the deflecting-plate and upper pole-ends, and gradually conducted to the lower pole ends, while the non-magnetic particles are dropped by gravity and collected in a separate receptacle from the magnetic particles. 4 claims.

9,010. "Improvements in electric railways." G. E. Baird. Dated May 7th. Relates to improvements in electric railways of that class in which the motors that propel the cars receive their current through a conductor lying in a conduit which runs along the car track. 13 claims.

9,056. "Safety appliance for electrical circuits." Siemens Bros. and Co., Ltd. (Communicated from abroad by Messrs. Siemens and Halske, of Berlin.) Dated May 7th. Consists of an auxillary conductor forming a closed loop with the main conductor, which, when carriages are running on the line, is connected in series with the main conductor which it is to protect. In this auxiliary conductor there is introduced at the source of current supply a closed circuit electromagnetic cut-out device of any suitable known construction, which cuts off the circuit from the source of supply simultaneously with the fracture of the conductor. 1 claim.